KALIBURN

Spirit275a

HIGH CURRENT DENSITY PLASMA CUTTING SYSTEM

WITH

AUTOMATIC GAS CONSOLE

User's Manual - Part Number 718085 Rev K
10/15/2012

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REVISION
K

REVISION HISTORY

Rev	ECO#	Author	Date	Description of Change
A	-			
B	-			As released
C	-		05/08/07	Changed location of coolant level switch
D	-		05/23//07	Changed 30A mild steel preflow pressure from 30 to 35 psi
E	-		07/02/07	Changed cutting charts to have separate metric and imperial versions. Changed 575V control xfmr part number to 706205
F	-		10/15/07	Added PAR relay in series with surge injection circuit to schematic and parts list
G	-		10/21/09	Section Updates: • Contents • Section 2 • Section 3 • Section 7 • Section 8
H	-		10/25/10	Section Updates • Contents • Section 3 • Section 4 • Section 5 • Section 6 • Section 7 • Appendix A • Appendix B - deleted
I	-		05/10/2011	Section Updates: • AGC Max Input Pressure change to 145 psi in: 2-4, 3-1, 3-13, 3-14, 8-8. • AGC Fan added to drawings in: 3-1, 3-13. • Postflow label changed in 8-9.
J			08/01/2012	• Section 1, added pointers to Section 7. • Section 7, added chopper warning. • Section 8, updated drawing of power supply microprocessor board.
K			10/15/2012	• Added Quick-Disconnect Torch information throughout manual. • Section 7, defective flow switch (25 blinks).

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LIMITED WARRANTY

KALIBURN expressly warrants that this product shall be free from defects in materials and workmanship, under proper and normal use for the intended function of such equipment, for a period of one (1) year for the Spirit275a torch and leads and three (3) years for the Spirit275a power supply and automatic gas console. This product is intended for commercial use and is not intended for personal, family, or household purposes. There are no warranties that extend beyond the description on the face hereof. **All other warranties, either expressed or implied, including any implied warranty of merchantability or fitness for any particular purpose, are expressly excluded.**

If this product or any component thereof is determined to be defective in manufacture, KALIBURN will repair or replace the defective component or product. The buyer's remedies are limited to the return of the product for repair or replacement of any non-conforming product or part at the sole discretion of KALIBURN. No freight charges of any kind are covered under this warranty. All returned goods shall be at the buyer's risk and expense. Beyond this remedy, KALIBURN will not be responsible for any special, incidental or consequential damages or injury to the person or property of anyone by reason of any defect in any equipment sold hereunder.

This warranty will be considered void if torches or torch consumables manufactured by anyone other than KALIBURN are incorporated into this product.

RETURNED GOODS PROCEDURE

KALIBURN utilizes a returned goods procedure that must be followed before returning any items for repair, replacement, or restocking. This means that a returned goods authorization number must be obtained prior to shipment to KALIBURN. It will be necessary for the customer to provide a description, along with the stock number and serial number, if applicable, of the item to be returned. In no case will KALIBURN accept a returned shipment without the proper returned goods authorization number.

For shipments inside the U.S., parts must be returned to KALIBURN within 30 days of the invoice date to be considered for credit. For shipments outside the U.S., parts must be returned within 60 days of the invoice date to be considered for credit.

ELECTROMAGNETIC COMPATIBILITY (EMC)

The 380V 50/60Hz and 415V 50/60Hz CE marked Spirit275a plasma cutting systems are manufactured to comply with the European standard EN 60974-10 (Electromagnetic compatibility (EMC) – Product standard for arc welding equipment). Information about the EMC standard EN 60974-10 can be found in Appendix A.

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Section 1 Safety

General Precautions

Whereas plasma cutting has been used safely for years, it does require certain precautions to ensure the safety of the operator and other people around the equipment. The following safety information must be provided to each person who will operate, observe, perform maintenance, or work in close proximity to this piece of equipment.

Installation, operation, and repairs made to the Spirit275a system should only be performed by qualified personnel. The Spirit system makes use of both A.C. and D.C. circuitry for operation. **Fatal shock hazard does exist. Exercise extreme caution while working on the system**.

Ultraviolet Radiation Protection

Plasma cutting produces ultraviolet radiation similar to a welding arc. This ultraviolet radiation can cause skin and eye burns. For this reason, it is essential that proper protection be worn. The eyes are best protected by using safety glasses or a welding helmet with an AWS No. 12 shade or ISO 4850 No. 13 shade, which provides protection up to 400 amperes. All exposed skin areas should be covered with flame-retardant clothing. The cutting area should also be prepared in such a way that ultraviolet light does not reflect. Walls and other surfaces should be painted with dark colors to reduce reflected light. Protective screens or curtains should be installed to protect additional workers in the area from ultraviolet radiation.

Noise Protection

The Spirit275a system generates high noise levels while cutting. Depending on the size of the cutting area, distance from the cutting torch, and arc current cutting level, acceptable noise levels may be exceeded. Proper ear protection should be used as defined by local or national codes. See Section 2 for noise emission levels.

Toxic Fume Prevention

Care should be taken to ensure adequate ventilation in the cutting area. Some materials give off toxic fumes that can be harmful or fatal to people in the vicinity of the cutting area. Also, some solvents decompose and

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form harmful gases when exposed to ultraviolet radiation. These solvents should be removed from the area prior to cutting.
Galvanized metal can produce harmful gases during the cutting process. Ensure proper ventilation and use breathing equipment when cutting these materials.

Certain metals coated with or containing lead, cadmium, zinc, beryllium, and mercury produce harmful toxins. Do not cut these metals unless all people subjected to the fumes wear proper air breathing equipment.

Electric Shock Prevention

The Spirit275a system uses high open circuit voltages that can be fatal. Extreme care should be used when operating or performing maintenance on the system. Only qualified personnel should service the Spirit system. Observe the following guidelines to protect against electric shock:

- A wall-mounted disconnect switch should be installed and fused according to local and national electrical codes. The disconnect switch should be located as close as possible to the power supply so it can be turned off in case of an emergency.
- The primary power cord should have a 600 volt minimum rating in order to protect the operator. In addition, it should be sized according to local and national electrical codes. Inspect the primary power cord frequently. Never operate the Spirit system if the power cord is damaged in any way.
- Make sure the primary power ground wire is connected to the input power ground stud on the Spirit power supply. Make sure the connection is securely tightened.
- Make sure the positive output (work ground) of the Spirit power supply is connected to a bare metal area on the cutting table. A driven ground rod should be placed no further than five feet from this connection. Make sure this ground point on the cutting table is used as the star ground point for all other ground connections.
- Inspect the torch leads frequently. Never use the system if the leads are damaged in any way.
- Do not stand in wet, damp areas when operating or performing maintenance on the system.
- Wear insulated gloves and shoes while operating or performing maintenance on the system.
- Make sure the Spirit system is switched off at the wall disconnect before servicing the power supply or torch.
- Never change torch consumable parts unless the Spirit system is switched off at the wall disconnect.

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- Do not attempt to remove any parts from beneath the torch when cutting. Remember that the workpiece forms the current path back to the power supply.
- Never bypass the safety interlock devices.
- Before removing any of the Spirit covers, switch the system off at the wall disconnect. Wait at least five (5) minutes before removing any cover. This will give the capacitors inside the unit time to discharge. See Section 7 for additional safety precautions.
- Never operate the Spirit system without all of the covers in place. See Section 7 for additional safety precautions.
- Preventive maintenance should be performed daily to avoid possible safety hazards.

Fire Prevention

When using the Spirit275a system, it is necessary to exercise good judgment. While cutting, the arc produces sparks that could cause a fire if they fall on flammable materials. Make sure that all flammable materials are a suitable distance away from the cutting area. All flammable liquids should be at least 40 feet away from the cutting area, preferably stored in a metal cabinet. Plasma cutting should never be attempted on containers that contain flammable materials. Make sure that fire extinguishers are readily accessible in the cutting area.

Make sure that the cutting area is properly ventilated when using oxygen as a cutting gas.

Explosion Prevention

The Spirit275a system uses compressed gases. Use proper techniques when handling compressed gas cylinders and other compressed gas equipment. Observe the following guidelines to protect against explosion:

- Never operate the Spirit system in the presence of explosive gases or other explosive materials.
- Never cut pressurized cylinders or any closed container.
- When using a water table and cutting aluminum under water or with water touching the underside of the aluminum plate, hydrogen gas is produced. This hydrogen gas may collect under the plate and explode during the cutting process. Make sure the water table is properly aerated to help prevent the accumulation of hydrogen gas.
- Handle all gas cylinders in accordance with safety standards published by the U.S. Compressed Gas Association (CGA), American Welding Society (AWS), Canadian Standards Association (CSA), or other local or national codes.
- Compressed gas cylinders should be maintained properly. Never

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attempt to use a cylinder that is leaking, cracked, or has other signs of physical damage.
- All gas cylinders should be secured to a wall or rack to prevent accidental knock over.
- If a compressed gas cylinder is not being used, replace the protective valve cover.
- Never attempt to repair compressed gas cylinders.
- Keep compressed gas cylinders away from intense heat, sparks, or flames.
- Clear the compressed gas cylinder connection point by opening the valve momentarily prior to installing a regulator.
- Never lubricate compressed gas cylinder valves or pressure regulators with any type of oil or grease.
- Never use a compressed gas cylinder or pressure regulator for any purpose other than which it is intended.
- Never use a pressure regulator for any gas other than which it is intended.
- Never use a pressure regulator that is leaking or has other signs of physical damage.
- Never use oxygen hoses and pressure regulators for any gas other than oxygen.
- Never use any gas hose that is leaking or has other signs of physical damage.

Health Support Equipment

The Spirit275a system creates electric and magnetic fields that may interfere with certain types of health support equipment, such as pacemakers. Any person who uses a pacemaker or similar item should consult a doctor before operating, observing, maintaining, or servicing the Spirit system. Observe the following guidelines to minimize exposure to these electric and magnetic fields:

- Stay as far away from the Spirit power supply, torch, torch leads, and remote high frequency console as possible.
- Route the torch leads as close as possible to the work ground cable.
- Never place your body between the torch leads and work ground cable. Keep the work ground cable and the torch leads on the same side of your body.
- Never stand in the center of a coiled up set of torch leads or work ground cable.

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Safety Standards Booklet Index

For further information concerning safety practices to be exercised with plasma arc cutting equipment, please refer to the following publications:

1. AWS Standard AWN, *Arc Welding and Cutting Noise*, obtainable from the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126.
2. AWS Standard C5.2, *Recommended Practices for Plasma Arc Cutting*, obtainable from the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126.
3. AWS Standard FSW, *Fire Safety in Welding and Cutting*, obtainable from the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126.
4. AWS Standard F4.1, Recommended *Safe Practices for Preparation for Welding and Cutting of Containers and Piping*, obtainable from the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126.
5. AWS Standard ULR, *Ultraviolet Reflectance of Paint*, obtainable from the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126.
6. AWS / ANSI Standard Z49.1, *Safety in Welding, Cutting, and Allied Processes,* obtainable from the American Welding Society, 550 NW LeJeune Road, Miami, FL 33126.
7. ANSI Standard Z41.1, *Standard For Men's Safety-Toe Footwear*, obtainable from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.
8. ANSI Standard Z49.2, *Fire Prevention in the Use of Cutting and Welding Processes*, obtainable from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.
9. ANSI Standard Z87.1, *Safe Practices For Occupation and Educational Eye and Face Protection,* obtainable from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.
10. ANSI Standard Z88.2, *Respiratory Protection*, obtainable from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

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11. OSHA Standard 29CFR 1910.252, *Safety and Health Standards,* obtainable from the U.S. Government Printing Office, Washington, D.C. 20402.

12. NFPA Standard 51, *Oxygen - Fuel Gas Systems for Welding, Cutting, and Allied Processes*, obtainable from the National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269.

13. NFPA Standard 51B, *Cutting and Welding Processes*, obtainable from the National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269.

14. NFPA Standard 70, *National Electrical Code*, obtainable from the National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269.

15. CGA booklet P-1, *Safe Handling of Compressed Gases in Containers*, obtainable from the Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202.

16. CGA booklet P-14, *Accident Prevention in Oxygen-Rich and Oxygen-Deficient Atmospheres*, obtainable from the Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202.

17. CGA booklet TB-3, *Hose Line Flashback Arrestors*, obtainable from the Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202.

18. CSA Standard W117.2, *Safety in Welding, Cutting, and Allied Processes*, obtainable from Canadian Standards Association, 178 Rexdale Boulevard, Toronto, Ontario M9W lR3, Canada.

19. Canadian Electrical Code Part 1, *Safety Standard for Electrical Installations,* obtainable from the Canadian Standards Association, 178 Rexdale Boulevard, Toronto, Ontario M9W 1R3, Canada.

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Section 2 Specifications

System Description

The Spirit275a is a 275 amp microprocessor controlled, 100% duty cycle high current density plasma cutting and marking system. It utilizes a precision, dual gas torch that is capable of cutting mild steel up to 2" thick and stainless steel up to 1-1/2" thick. The Spirit275a is equipped with a computer controlled automatic gas console with VGA display. All cutting parameters are controlled from the automatic gas console. Setting up a cut is as simple as entering the material type, material thickness, and process (cutting or marking). All gas types and pressures are set automatically and the cutting parameters are transmitted to the Spirit power supply. Switching to a different screen on the gas console gives the operator a pictorial view of the torch parts required to make the cut. Another screen shows the recommended cutting speed and torch height for making the cut. These parameters can even be transmitted to an x/y machine controller or an arc voltage control system via RS-422 serial communication. The RS-422 port also allows for full control of the cutting parameters from an x/y machine controller. The gas console also tracks the number of cuts made with a particular set of consumables and keeps a detailed record of errors that may occur during the cutting sequence. To aid in troubleshooting, a message screen on the gas console displays all power supply and gas console sequencing. All gas inlets and outlets are connected to the rear of the automatic gas console. For cutting mild steel, the Spirit275a uses oxygen for the plasma gas and either oxygen or air for the shielding gas. When cutting stainless steel or other non-ferrous materials, air or H17 (17.5% hydrogen, 32.5% argon, 50% nitrogen) is used for the plasma gas and either air or nitrogen is used for the shielding gas. Oxygen and nitrogen are used for the preflow and postflow gases.

The Spirit275a is technologically advanced to produce the highest quality cuts while maximizing consumable life. The torch is water-cooled and consumables are machined to exacting dimensions and checked with the latest computerized measuring systems. Eight nozzle sizes (30, 50, 70, 100, 150, 200, 260 and 275 amps) are available to produce excellent cut quality throughout the cutting range.

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System Components

The degree of protection provided by the Spirit275a system is IP21S and as such is intended only for indoor use. It is not suitable for use in rain or snow.

The Spirit275a system is tested in accordance with CISPR 11, EMC classification – Group 2 ISM (Class A).

The Spirit275a consists of the following components:

Standard Components

- Power Supply
- Automatic Gas Console
- Remote High Frequency (RHF) Console
- RHF Console Control Cable
- Torch and Handle Assembly
- Torch Lead Set
- 5-gang Manifold Assembly
- 5-gang Manifold Control Cable
- 2-gang Manifold Assembly
- 2-gang Manifold Control Cable
- Water and Power Leads
- Gas Hose Package
- Work Ground Lead
- System Manual
- Consumable Spare Parts Kit (see Section 8 for details)

Optional Components

- Supply Gas Hoses (see Section 8 for details)

Power Supply Specifications

Stock Number:

208 VAC, 3Ø, 60Hz	280410
230 VAC, 3Ø, 60Hz	280411
380 VAC, 3Ø, 50/60Hz	280414
415 VAC, 3Ø, 50/60Hz	280415
460 VAC, 3Ø, 60Hz	280412
575 VAC, 3Ø, 60Hz	280413

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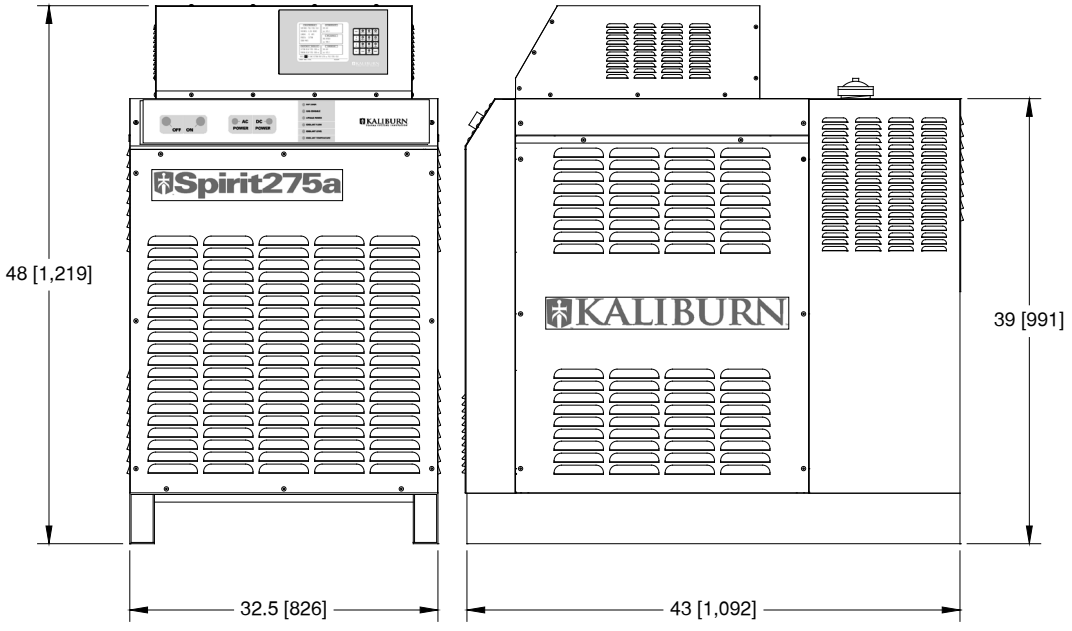
Input Current at Maximum Output:
- 208 VAC, 3Ø, 60Hz ..... 147 amps
- 230 VAC, 3Ø, 60Hz ..... 133 amps
- 380 VAC, 3Ø, 50/60Hz ..... 81 amps
- 415 VAC, 3Ø, 50/60Hz ..... 74 amps
- 460 VAC, 3Ø, 60Hz ..... 67 amps
- 575 VAC, 3Ø, 60Hz ..... 53 amps

Open Circuit Voltage ..... 325 VDC
Output Current (drooping characteristic)..... 10 - 275 amps
Maximum Output Voltage ..... 180 VDC
Duty Cycle ..... 100% @ 41.3 kW
Maximum Ambient Temperature ..... 104° F (40° C)
Dimensions:
- Width ..... 32.5 in (826 mm)
- Height (including AGC) ..... 48 in (1219 mm)
- Depth ..... 43 in (1092 mm)

Weight (including AGC) ..... 1315 lb (596 kg)

Torch Cooling System:
- Discharge pressure ..... 150 psi (10.2 bar)
- Flow rate ..... 1 gal/min (3.8 liters/min)
- Coolant fluid ..... Propylene glycol/deionized water
- Coolant tank capacity ..... 3.2 gal (12 liters)



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Automatic Gas Console Specifications

Stock Number 280002
Height .....9 in (229 mm)
Width .....25 in (635 mm)
Depth ..... 23.8 in (605 mm)
Weight .....110 lb (50 kg)

Gas Supply Requirements

Plasma gas types:
- Mild Steel ..... Oxygen or Air
- Stainless Steel ..... Air or H17
- Aluminum ..... Air

Shield gas types:
- Mild Steel ..... Oxygen or Air
- Stainless Steel ..... Air or Nitrogen
- Aluminum ..... Air or Nitrogen

Preflow gas type ..... Oxygen and Nitrogen
Marking gas type .....Nitrogen

Plasma gas flow rate (maximum):
- Oxygen or Air ..... 67 scfh (1897 liters/hour)
- H17 .....75 scfh (2124 liters/hour)

Shield gas flow rate (maximum):
- Oxygen .....19 scfh (538 liters/hour)
- Air or Nitrogen .....225 scfh (6371 liters/hour)

Preflow gas flow rate (maximum) .....60 scfh (1699 liters/hour)
Marking gas flow rate (maximum) .....79 scfh (2237 liters/hour)
Rated Inlet gas pressure ..... 120 psi (8.3 bar)
Maximum Inlet gas pressure…….145 psi (10.0 bar)

Oxygen and nitrogen should be supplied with a purity of at least 99.5%. H17 should be supplied with a purity of at least 99.995% **A potential fire hazard exists when cutting with oxygen. KALIBURN recommends that an exhaust ventilation system be used when cutting with oxygen. Flashback arrestors must be supplied (unless they are not available for the chosen gases and pressures) to prevent a possible fire from propagating back to the gas supplies.** Ensure that oxygen lines remain free from contaminants such as oil and grease. The mixture of such contaminants with oxygen presents an additional fire hazard. Compressed air must be clean, dry, and oil-free and may be supplied from compressed cylinders or from an air compressor. Be aware that shop air systems are prone to oil and moisture contamination. If shop air is used, it must be cleaned to ISO 8573.1: Class 1.4.1. Specify dry air when using compressed cylinders. Breathing quality air contains moisture and must not be used. 3/8" (inside diameter) hoses are required for all inlet gas connections. Mating connectors are supplied with the unit. **Quick-connect fittings must not be used.**

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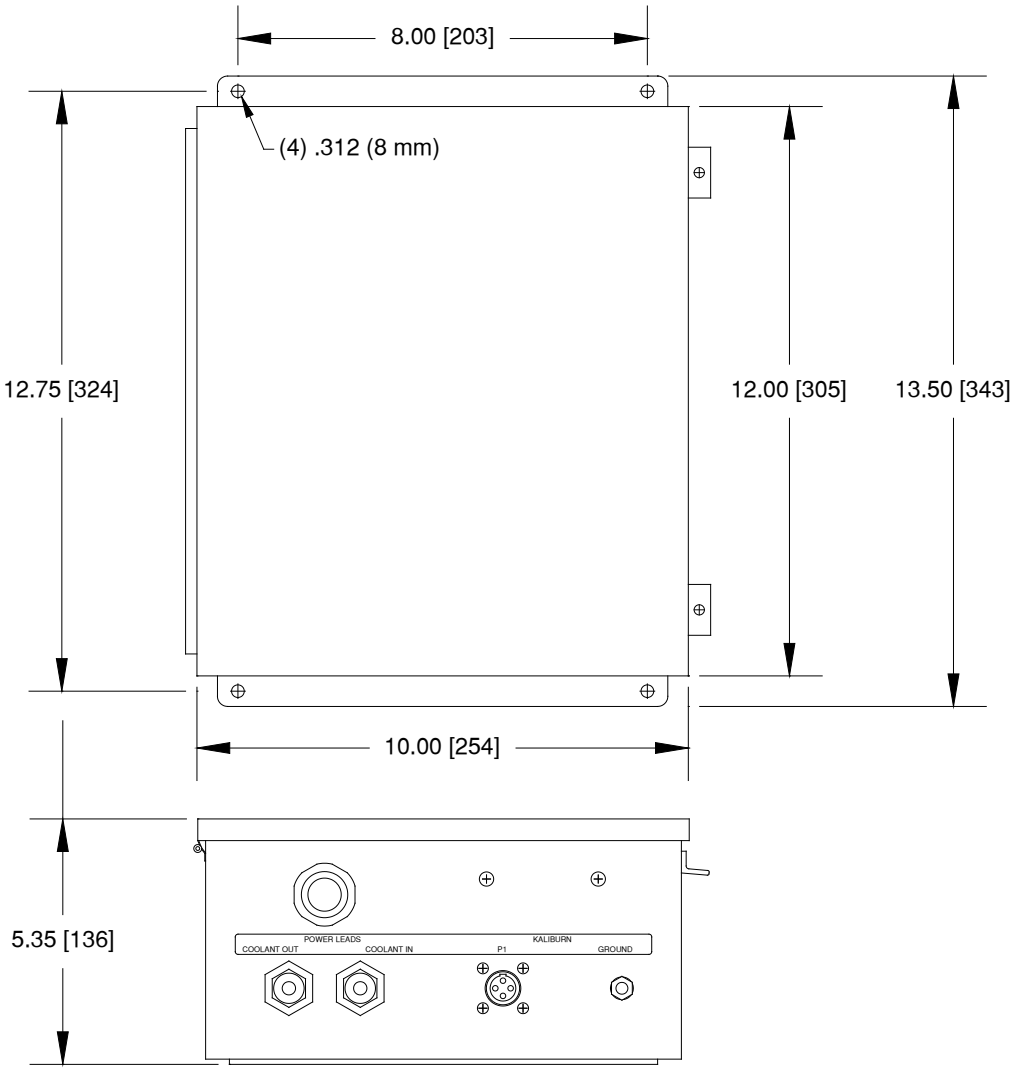
Remote High Frequency Console Specifications

Stock Number 205500
Height .....5.35 in (136 mm)
Width .....13.5 in (343 mm)
Depth ..... 10 in (25 mm)
Weight .....22 lb (10 kg)
Spark gap distance ..... .015 in (.381 mm)



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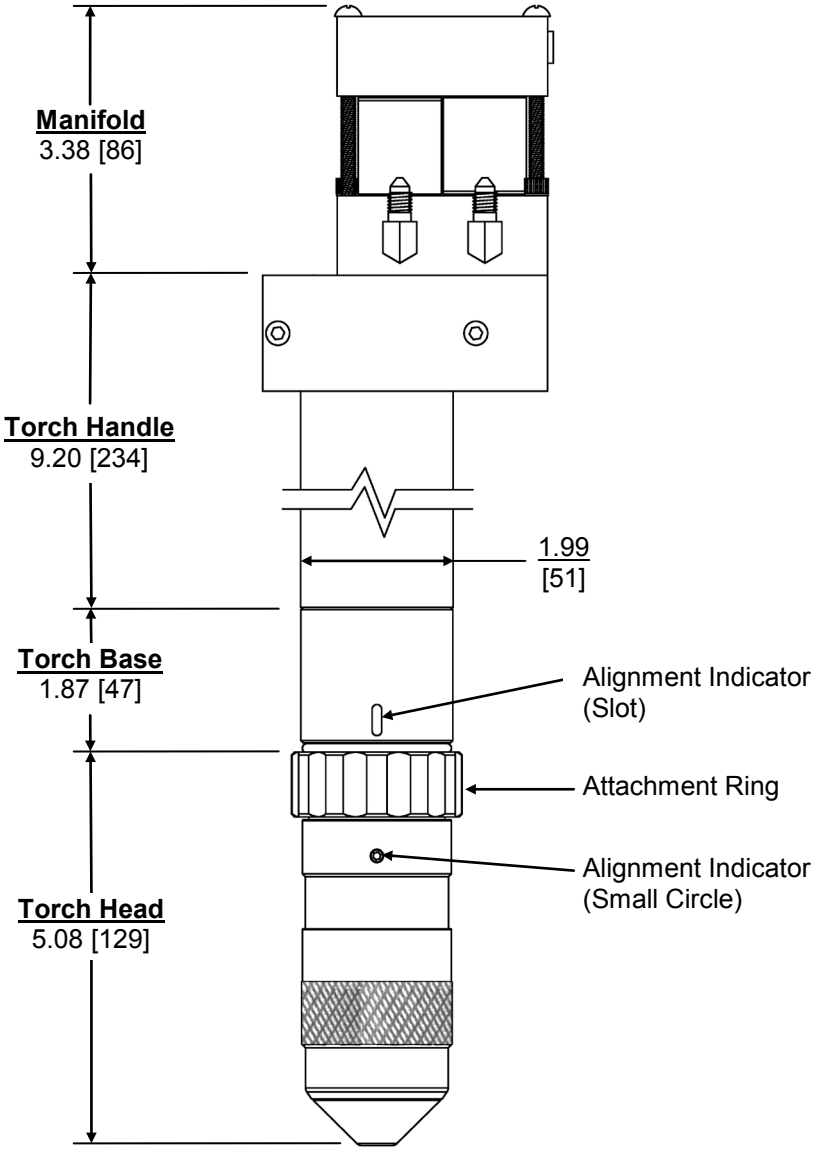
Torch Specifications

Stock Number:

2-Gang Manifold Assembly	260214
Torch Handle	820134
Torch Base	279050
Torch Head (Copper Electrode)	279150
Torch Head (Silver Electrode)	279160

Weight:

Manifold/Bracket, Handle, Base and Head	7.3 lbs (3.3 kg)



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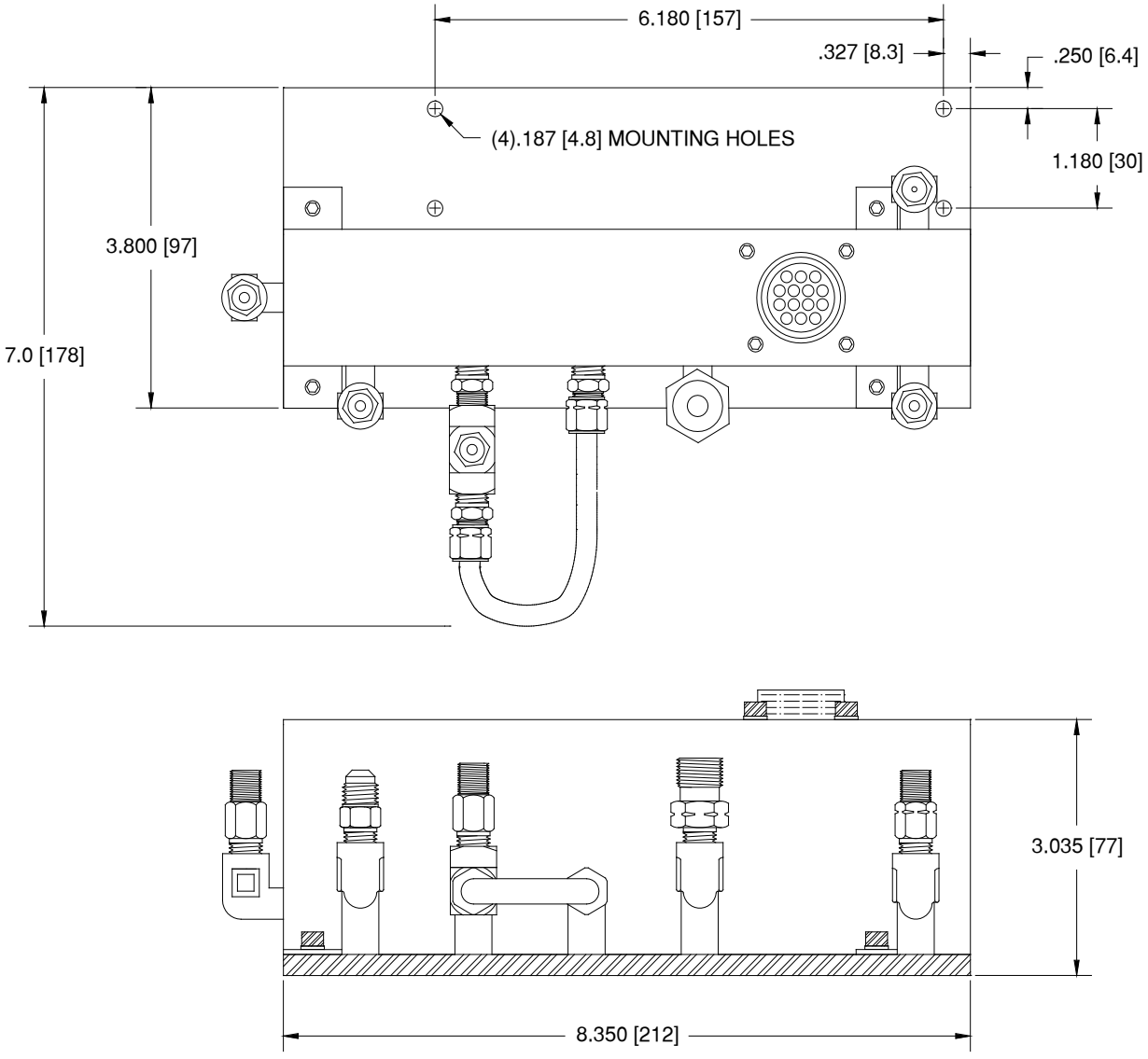
5-Gang Manifold Specifications

Stock Number 280022
Height .....3.035 in (77 mm)
Width .....8.35 in (212 mm)
Depth ..... 7 in (178 mm)
Weight .....6 lb (2.7 kg)



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Airborne Noise Emissions

The Spirit275a system generates high noise levels while cutting. Depending on the size of the cutting area, distance from the cutting torch, and arc current cutting level, acceptable noise levels may be exceeded. Proper ear protection should be used as defined by local or national codes. The following chart gives the noise levels generated by the Spirit275a when operating at 275 amps, 145 arc volts. The measurements were made with a sound level meter.

Distance From Torch	A-Weighted Sound Pressure Level	C-Weighted Sound Pressure Level
1 meter horizontal / 1.6 meters above the workpiece	110 dB	107 dB

The maximum noise level is 127 dB at a distance of 3 inches (76.2 mm) from the torch while cutting at 275 amps, 145 arc volts.

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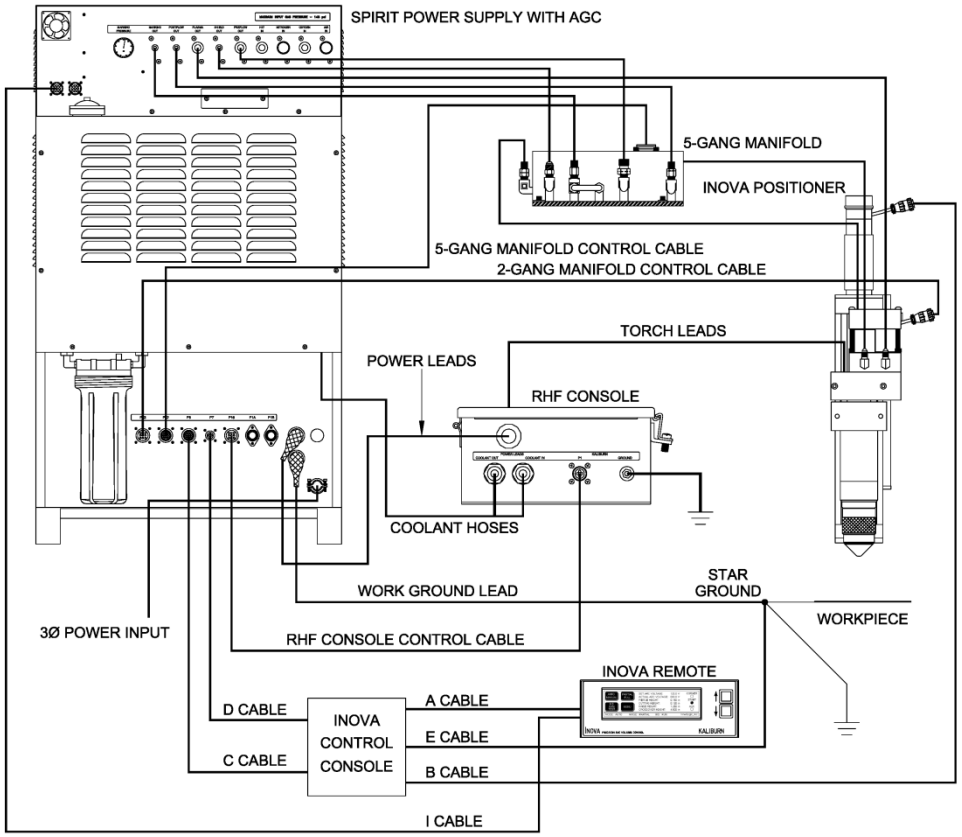
Section 3 Installation

Initial Inspection

All systems undergo full testing before being shipped from KALIBURN. In the unlikely event that one of your components is defective or missing, please contact KALIBURN so a replacement item can be sent to you. Also, KALIBURN has taken special care in packaging your Spirit275a system. If your system was damaged during shipment, you will have to file a claim with the shipping company. Next, it will be necessary to contact KALIBURN so replacement parts can be ordered. If you need additional assistance, please contact KALIBURN.

System Interconnection

The Spirit275a system interconnection diagram shown below will assist you in identifying cables and hoses upon receipt of your system. Electrical cables are marked with the appropriate plug number or letter and can be identified on the diagram. The Inova arc voltage control is also shown to assist in its hookup.



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Power Supply Installation

The Spirit power supply should be lifted by a forklift or pallet jack. In order to prevent damaging the power supply, the forks should be of adequate length to protrude on the far side of the power supply. The proper location of the power supply will provide dependable service and reduce periodic maintenance time. Choose a location that will provide unrestricted air movement into and out of the power supply. Maintain **at least 24 inches** of space on **all** sides of the unit. The location should subject the power supply to the least amount of dust, dirt, moisture, and corrosive vapors. The surface on which the power supply is located should have a grade of no greater than 10º to eliminate the risk of toppling over. The power supply must be cleaned as often as necessary to prevent the accumulation of metallic dust inside the unit. See Section 2 for power supply dimensions.

Remote High Frequency Console Installation

The remote high frequency (RHF) console should be mounted in a convenient location that is away from other electronic control devices. The high voltage, high frequency signal generated inside the unit can interfere with the operation of certain control systems. The RHF console is usually mounted on the gantry of the cutting machine or on the cutting table. See Section 2 for RHF console mounting dimensions.

5-Gang Manifold Installation

The 5-gang manifold assembly must be mounted within 6 feet (1.8 m) of the torch. See Section 2 for 5-gang manifold mounting dimensions.

Torch Installation

The Spirit275a torch must be installed on the positioner of an arc voltage control capable of maintaining the cutting arc voltage within 1 arc volt. The arc voltage must be adjustable in 1 arc volt increments. The positioner must be rigid to ensure cut quality and a torch collision sensor is highly recommended. See Section 2 for torch mounting dimensions.

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Primary Power Connection

**** Before connecting primary power, check the data plate to verify the voltage required by the Spirit power supply ****

A primary disconnect switch, switching all ungrounded supply conductors, should be provided for each Spirit power supply. The disconnect switch should be located as close as possible to the power supply so it can be turned off quickly in case of an emergency. **The disconnect switch should be equipped with time delay fuses only**. The magnetic inrush current of the power supply will cause fast acting fuses to blow. The disconnect switch should be sized according to local and national codes. The rating must meet or exceed the continuous rating of the fuses used. See the following chart for recommended fuse sizes:

3 Phase Input Voltage (VAC)	Input Current at Maximum Output (amps)	Recommended Time-Delay Fuse Size (amps)
208V 60Hz	147	200
230V 60Hz	133	190
380V 50/60Hz	81	125
415V 50/60Hz	74	100
460V 60Hz	67	95
575V 60Hz	53	75

Use a Type SO power cable to connect the primary power to the Spirit power supply. The power cable should have a 600 volt minimum rating and should be sized according to local and national codes. Route the power cable through the lower strain relief on the rear of the power supply and connect it to the input terminal block TB5 as shown. TB5 is located on the base of the power supply behind the left side cover. **Be sure to connect the primary ground cable to the ground stud on the input terminal block**.

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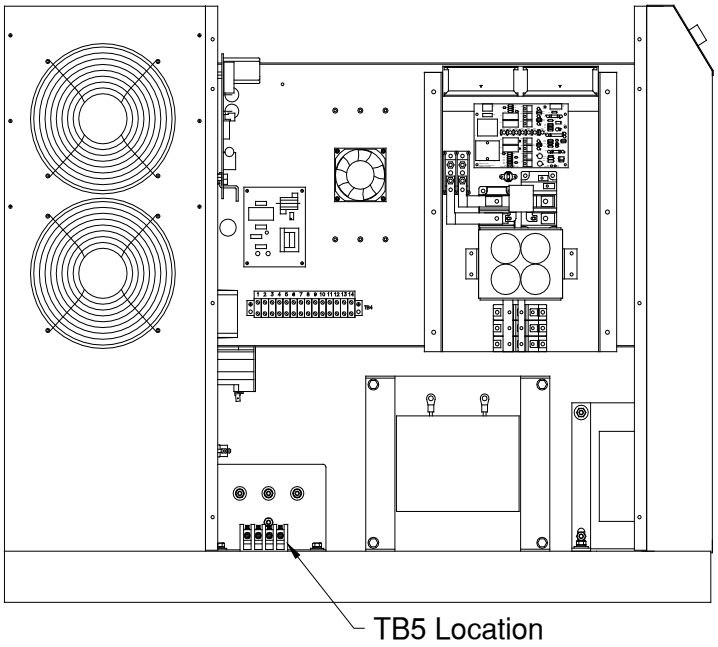

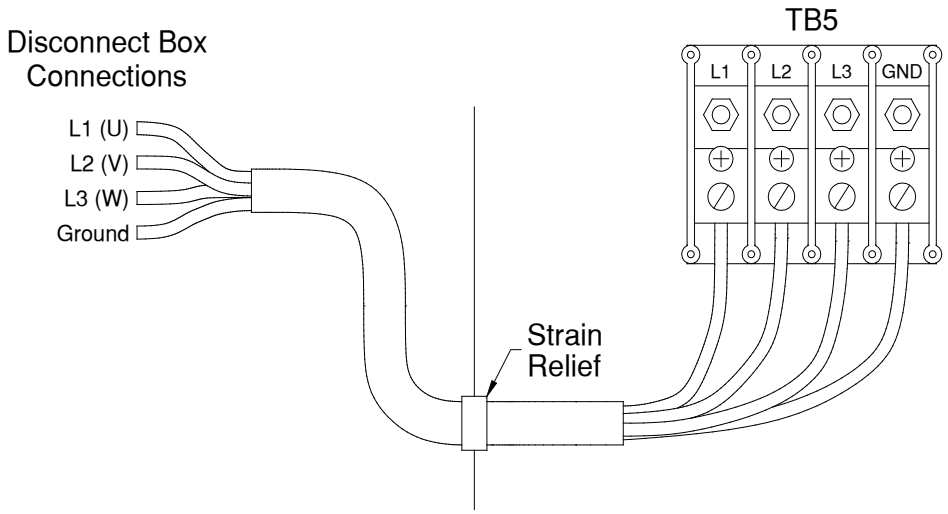

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Power Supply Output Connections

Perform the following steps to connect the output of the power supply to the RHF console and the work table. See figure below.

Power Supply Electrode Lead (1)

1. Route one end of the #1/0AWG power supply electrode lead through the upper strain relief on the rear of the power supply and connect it to the electrode terminal.
2. Route the other end of the power supply electrode lead through the strain relief on the RHF console and connect it to the cathode manifold.

Power Supply Nozzle Lead (2)

1. Route one end of the #10AWG power supply nozzle lead through the upper strain relief on the rear of the power supply and connect it to the nozzle terminal.
2. Route the other end of the power supply nozzle Lead through the strain relief on the RHF console and connect it to the pilot terminal on the RHF console printed circuit board.

Power Supply CTP Sensor Lead (3)

1. Route the end of the #14AWG power supply CTP sensor lead with the ring terminal through the middle strain relief on the rear of the power supply and connect it to the CTP terminal.
2. Route the end of the power supply CTP sensor lead with the fast-on terminal through the strain relief on the RHF console and connect it to the CTP sensor lead filter assembly.

RHF Console Control Cable (4)

1. Connect the RHF console control cable plug labeled P16 to the connector labeled P16 on the rear of the power supply.
2. Connect the RHF console control cable plug labeled P1 to the connector labeled P1 on the RHF console.

Power Supply Coolant Supply Hose (5)

1. Connect one end of the power supply coolant supply hose to the coolant supply fitting on the rear of the power supply. Note that the coolant supply fitting has right hand threads.
2. Connect the other end of the power supply coolant supply hose to the coolant in fitting on the RHF console. Note that the coolant in fitting has right hand threads.

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Power Supply Coolant Return Hose (6)

1. Connect one end of the power supply coolant return hose to the coolant return fitting on the rear of the power supply. Note that the coolant return fitting has left hand threads.
2. Connect the other end of the power supply coolant return hose to the coolant out fitting on the RHF console. Note that the coolant out fitting has left hand threads.

Work Ground Lead (7)

1. Route one end of the #1/0AWG work ground lead through the middle strain relief on the rear of the power supply and connect it to the work terminal.
2. Connect the other end of the work ground lead to the star ground point on the cutting table. The star ground point is generally referred to as the common ground point on the cutting table where all subsystems of the machine are grounded. This point is then connected to a driven earth ground rod that should be as close as possible to the star ground. The ground rod should have no other wires connected to it. The ground rod should be at least 3/4 inches in diameter and should be driven into the earth's permanent moisture layer. The length of the ground rod varies from installation to installation and should be installed according to local and national codes. Refer to the National Electrical Code, Article 250, Section H, Ground Electrode System for additional information.

RHF Console Ground Connection (8)

Perform the following steps to connect the chassis of the RHF console to the cutting table. See figure below.

1. Connect one end of the RHF console ground lead to the ground stud on the RHF console.
2. Connect the other end of the RHF console ground lead to chassis ground on the cutting table. Make sure that good metal-to-metal contact is made.

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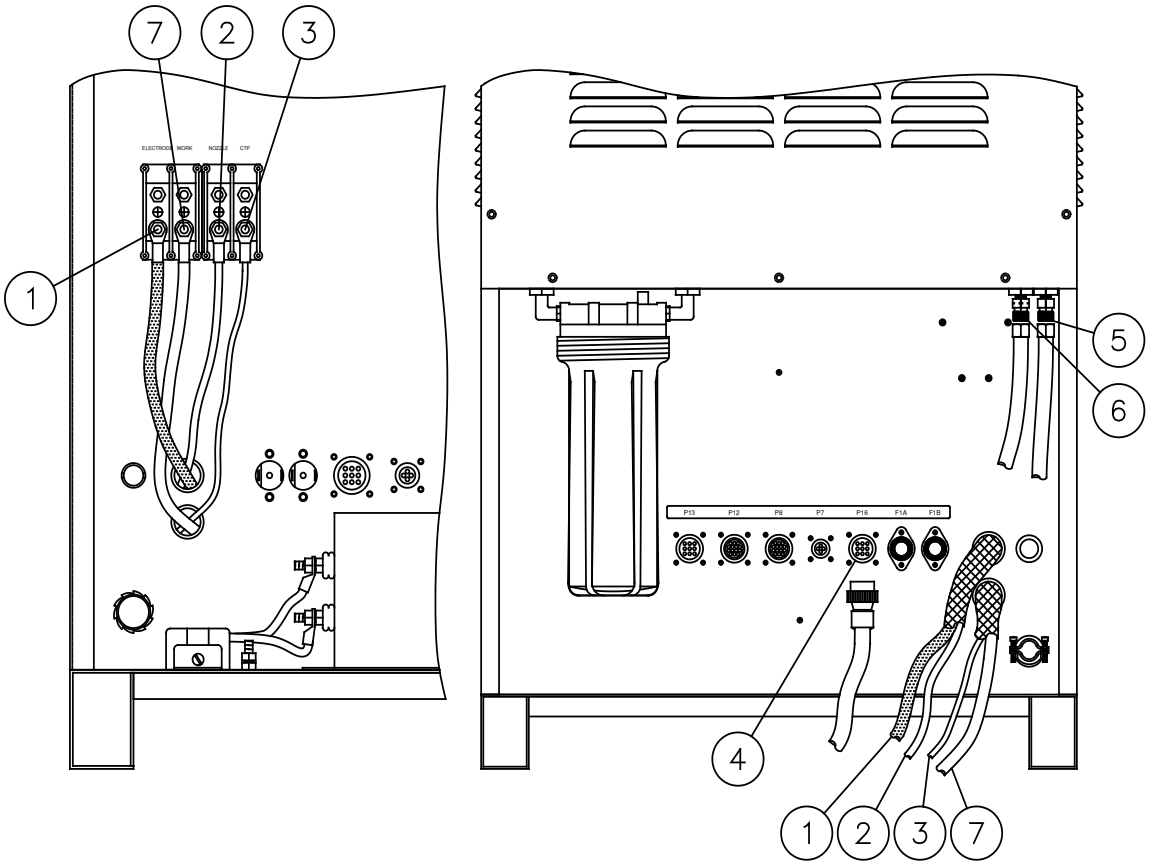

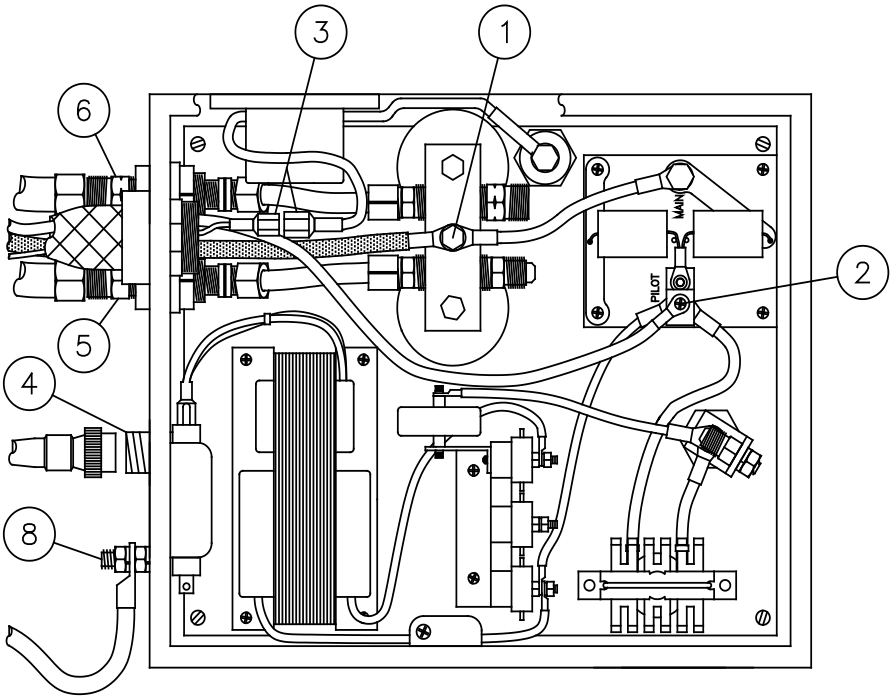

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Torch Leads to RHF Console Connections

Perform the following steps to connect the torch leads to the RHF console. See figure below.

Note: When making hose connections, only tighten the brass fittings enough to make water or gas seals. The fittings are subject to damage if over tightened.

Braided Shield (9)

1. Remove the threaded ring from the brass shield connector on the end of the braided shield. Route the torch leads through the opening in the RHF console and push the shield connector through the hole until it is seated against the side of the console.
2. Slide the threaded ring over the torch leads, thread it onto the brass shield connector, and **tighten firmly**. The shield connector should ground the braided shield to the case of the RHF console in order to help reduce high frequency noise emission. Using an ohmmeter, measure for zero ohms between the braided shield and the ground stud located on the outside of the RHF console.

Torch Electrode/Coolant Supply Lead (10)

- Connect the torch electrode/coolant supply lead to the brass cathode manifold. Note that the torch electrode/coolant supply lead has right hand threads.

Torch Coolant Return Lead (11)

- Connect the torch coolant return lead to the brass cathode manifold. Note that the torch coolant return lead has left hand threads.

Torch Nozzle Lead (12)

- Connect the torch nozzle lead to the angled bracket on the red standoff. Note that the torch nozzle lead has right hand threads.

Torch CTP Sensor Lead (13)

- Connect the #18AWG torch CTP sensor lead to the red standoff as shown.

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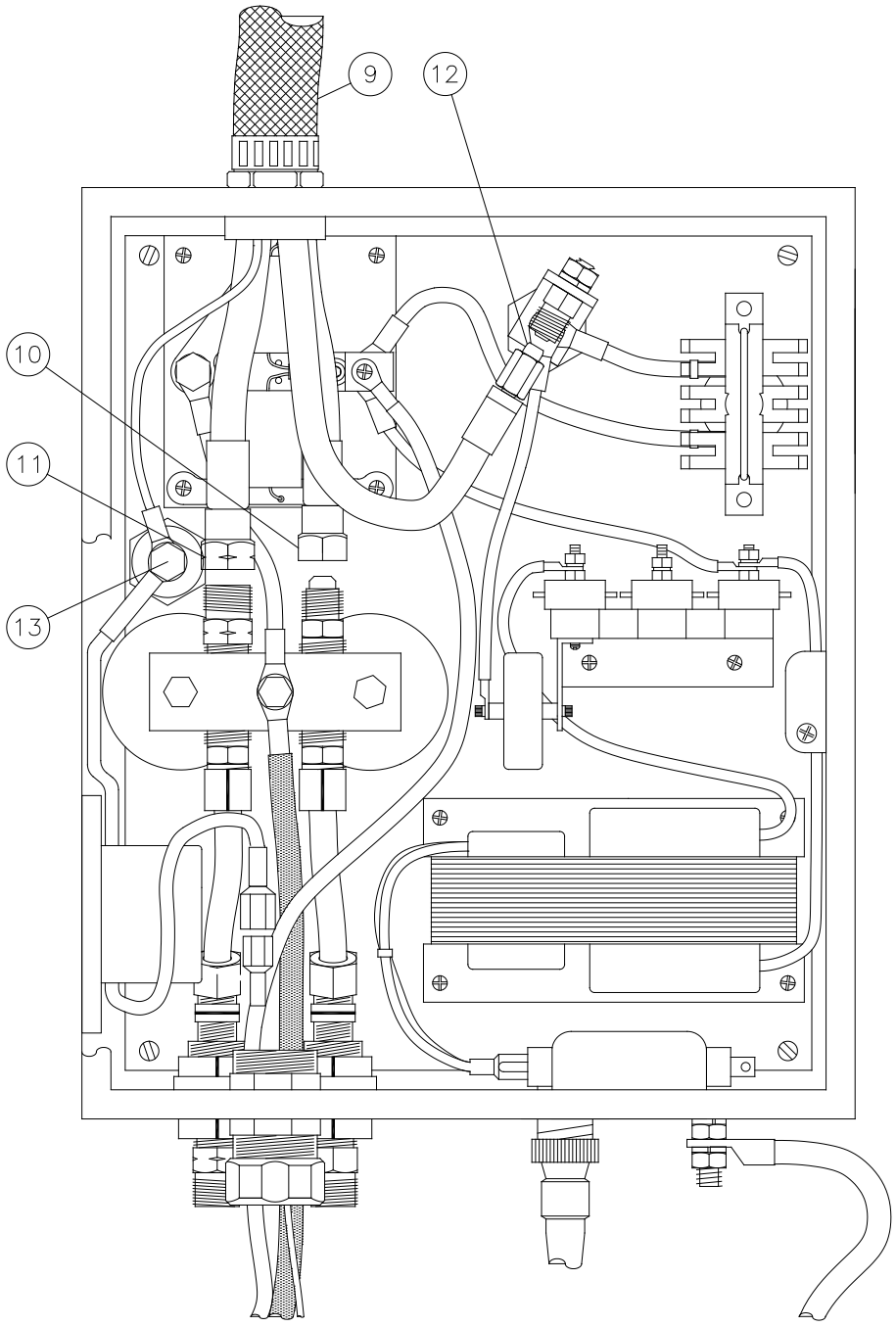

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Torch Leads to Torch Base Connections

Perform the following steps to connect the torch leads to the torch base.

Note: When making hose connections, only tighten the brass fittings enough to make water or gas seals. The fittings are subject to damage if over tightened. Also, use two wrenches when tightening the torch fittings to avoid damaging the torch

Torch Handle Installation

1. Route the torch leads through the torch handle. Note that the threaded end of the torch handle mates with the torch base.

Torch Electrode/Coolant Supply Lead (10)

- Connect the torch electrode/coolant supply lead to the torch base as shown.

Torch Coolant Return Lead (11)

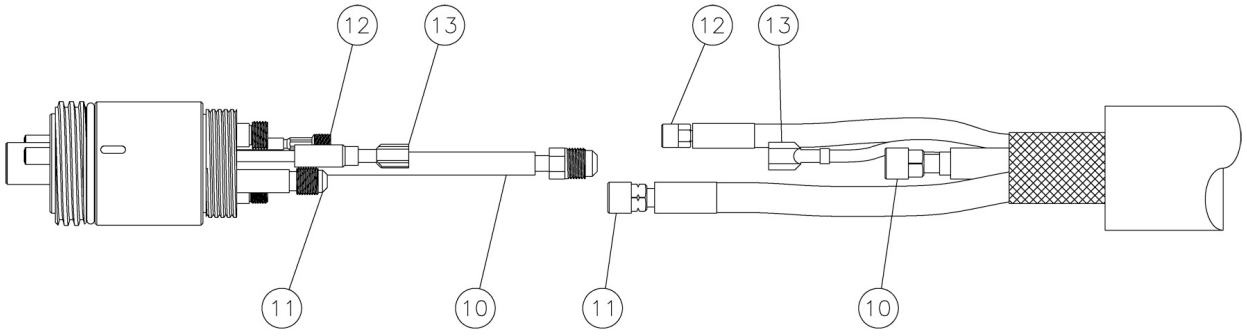
- Connect the torch coolant return lead to the torch base as shown. Note that the torch coolant return lead fitting has left hand threads.

Torch Nozzle Lead (12)

- Connect the torch nozzle lead to the torch base as shown.

Torch CTP Sensor Lead (13)

- Connect the torch CTP sensor lead to the torch base as shown.



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Torch Gas Connections

Perform the following steps to connect the torch gas hoses to the automatic gas console, torch base, and torch valve assemblies. See figure below.

Note: When making hose connections, only tighten the brass fittings enough to make gas seals. The fittings are subject to damage if over tightened.

7.5 Foot Shield Gas Hose (14)

1. Route one end of the 7.5foot (2.3 m) shield gas hose through the torch handle and connect to the shield gas fitting on the torch base.
2. Connect the other end of the 7.5 foot (2.3 m) shield gas hose to the shield gas outlet on the 5-gang manifold.

15 Inch Plasma Gas Hose (15)

1. Route one end of the 15 inch (380 mm) plasma gas hose through the torch handle and connect to the plasma gas fitting on the torch base.
2. Thread the torch handle onto the torch base, being careful not to twist the torch leads and gas hoses when tightening the torch handle.
3. Tighten the base to the handle using a pin style adjustable spanner wrench (fits 2" diameter with ¼" diameter pin).
4. Attach the 2-gang manifold assembly to the torch handle. The top of the manifold bracket should be flush with the top of the torch handle.
5. Mount the torch handle/base/manifold to the positioner. Note the alignment indicators on the torch base (slot) and torch head (small circle). These aid in aligning the quick-disconnect torch base and head and should be oriented so they are clearly visible when the operator is changing heads.
6. Connect the other end of the 15 inch (380 mm) plasma gas hose to the plasma gas outlet on the 2-gang manifold.

6 Foot Preflow/Postflow/Marking Gas Hose (16)

1. Connect one end of the 6 foot (1.8 m) preflow/postflow/marking gas hose to the preflow/postflow/marking outlet on the 5-gang manifold.
2. Connect the other end of the 6 foot (1.8 m) preflow/postflow/marking gas hose to the preflow/postflow/marking inlet on the 2-gang manifold.

Marking Gas Hose (17)

1. Connect one end of the marking gas hose to the marking outlet on the rear of the AGC.
2. Connect the other end of the marking hose to the marking inlet on the 5-gang torch valve assembly.

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Postflow Gas Hose (18)

1. Connect one end of the postflow hose to the postflow outlet on the rear of the AGC. Note that the postflow hose fittings have left hand threads.
2. Connect the other end of the postflow hose to the postflow inlet on the 5-gang torch valve assembly.

Plasma Gas Hose (19)

1. Connect on end of the plasma hose to the plasma outlet on the rear of the AGC.
2. Connect the other end of the plasma hose to the plasma inlet on the 2-gang torch valve assembly.

Shield Gas Hose (20)

1. Connect one end of the shield hose to the shield outlet on the rear of the AGC.
2. Connect the other end of the shield hose to the shield inlet on the 5-gang torch valve assembly.

Preflow Gas Hose (21)

1. Connect one end of the preflow hose to the preflow outlet on the rear of the AGC. Note that the preflow hose fittings have left hand threads.
2. Connect the other end of the preflow hose to the preflow inlet on the 5-gang torch valve assembly.

5-Gang Manifold Control Cable (22)

1. Connect the 5-gang manifold control cable plug marked P15 to the 5-gang manifold as shown.
2. Connect the 5-gang manifold control cable plug labeled P12 to the connector labeled P12 on the rear of the power supply.

2-Gang Manifold Control Cable (23)

1. Connect the 2-gang manifold control cable plug marked P18 to the 2-gang manifold as shown.
2. Connect the 2-gang manifold control cable plug labeled P13 to the connector labeled P13 on the rear of the power supply.

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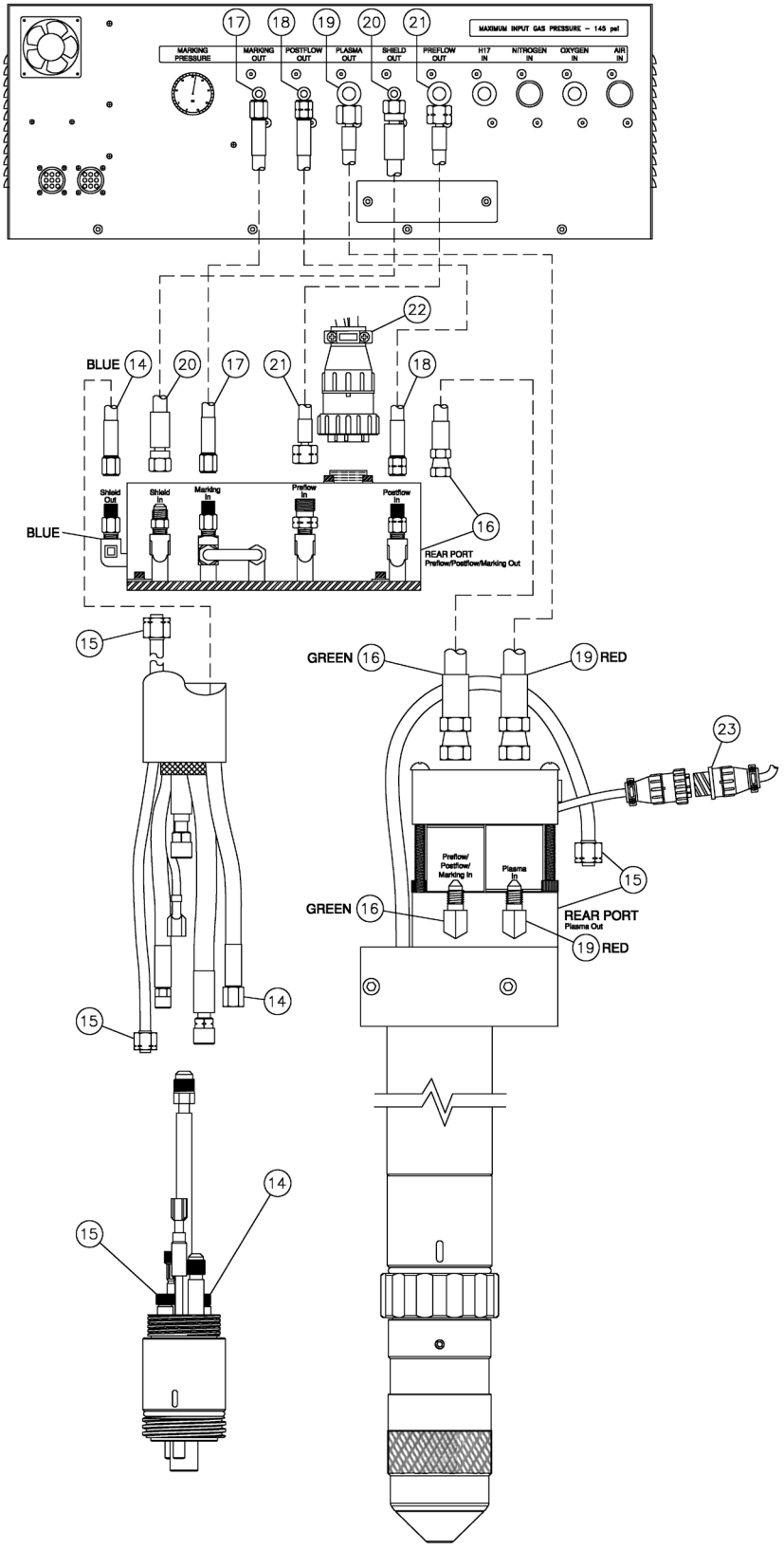

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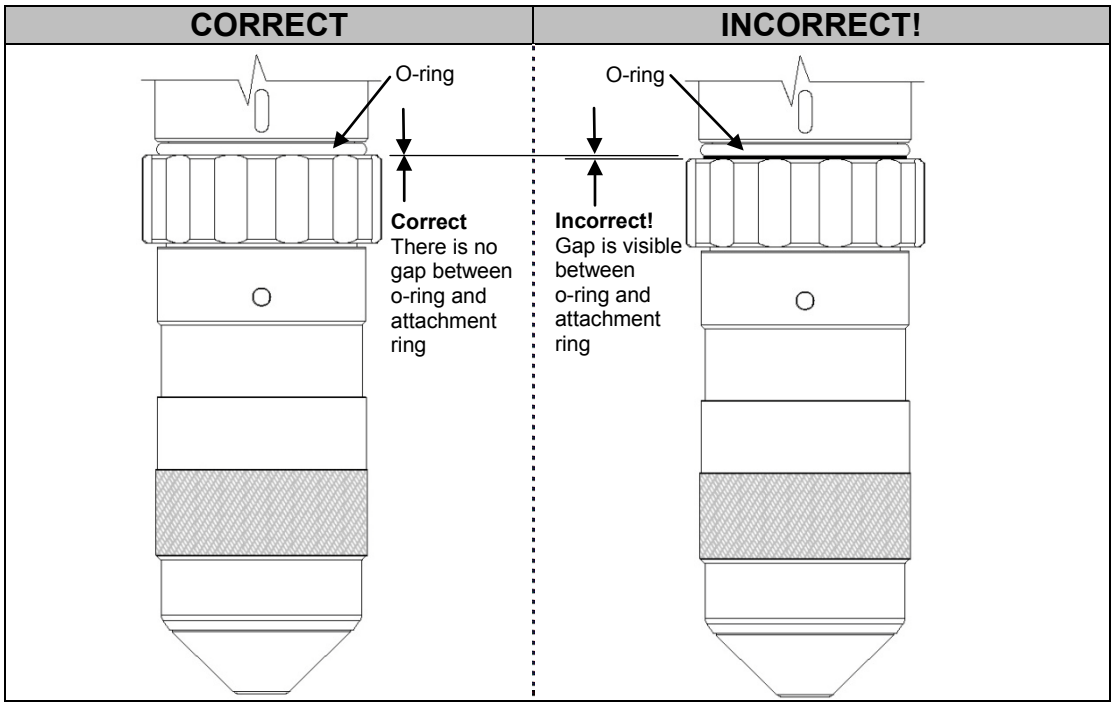
Torch Head Connection

Perform the following steps to connect the torch head to the torch base.

1. Each time the torch head is connected to the torch base, use a cotton swab to apply a small amount of o-ring lubricant on each of the seven o-rings on the top of the torch head. **Reminder: do not use an excessive amount of o-ring lubricant.**
2. Align the indicator on the torch head (small circle) with the one on the torch base (slot).
3. Apply enough upward force to engage the threads while tightening the attachment ring. Turn the attachment ring to the LEFT to tighten.
4. Keep tightening the attachment ring until it stops. As shown below, the attachment ring will NOT cover the o-ring. This is only a visual indicator; no seal is created. However, there should be no gap between the attachment ring and the o-ring.

   During the tightening process (after the initial install) a small amount of coolant will collect in the torch head. It is normal for this coolant to discharge between the o-ring on the torch base and the attachment ring while the system is being pressurized. If coolant continues to discharge after the system is pressurized, turn off the plasma power supply, remove the torch head and inspect the o-rings for damage.



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Automatic Gas Console Input Connections

Perform the following steps to connect the gas supply lines to the automatic gas console. See Section 2 for gas supply requirements. Mating hose barbs and connectors are supplied with the system and are sized for 3/8 inch inside diameter hose. **Do not change the inlet gas supply fittings to quick-connect fittings. Using quick-connect fittings to connect and disconnect pressurized hoses may cause damage to the system.**

Note: When making hose connections, only tighten the brass fittings enough to make gas seals. The fittings are subject to damage if over tightened.

Air Inlet (24) (ISO 3821 hose color – black)

- Air must be supplied to the unit at all times, regardless of the cutting current or material type.

Oxygen Inlet (25) (ISO 3821 hose color – blue)

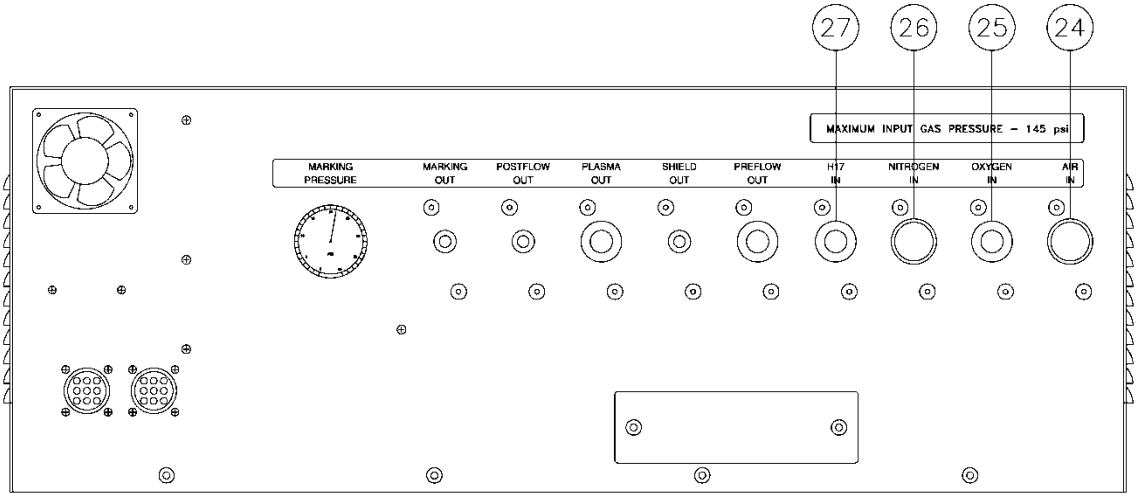
- Oxygen must be supplied to the unit at all times, unless stainless steel is being cut with H17 plasma.

Nitrogen Inlet (26) (ISO 3821 hose color – black)

- Nitrogen must be supplied to the unit at all times, regardless of the cutting current or material type.

H17 Inlet (27) (ISO 3821 hose color – red)

- H17 must be supplied to the unit when stainless steel is being cut with H17 as the plasma gas. See cutting charts in Section 4 for more information.



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CNC Machine Interface Connections

Perform the following steps to properly interface the Spirit275a system with a CNC cutting machine. See the system schematic for additional information.

Plasma Start Input

- The Spirit275a requires a contact closure between P8 pins 3 and 4 to commence the cutting or marking sequence. The sequence is terminated when the contacts are opened. The contacts should be rated for 12VDC - 10mA.

Plasma Cut/Mark Input

- The Spirit275a requires a contact closure between P8 pins 1 and 2 to put the system in plasma marking mode. Opening the contacts puts the system in cutting mode. The operating mode should be selected prior to applying a start signal. The contacts should be rated for 12VDC - 10mA.

Arc Hold Input

- The Spirit275a requires a contact closure between P8 pins 10 and 11 to inhibit arc starting even though a plasma start signal has been applied to the unit. When the contacts are opened, the arc is initiated. This feature is used to decrease cycle time by allowing pre-cut gas and contact sequencing to occur simultaneously with initial torch height positioning. The contacts should be rated for 12VDC - 10mA.

Motion Output

- The Spirit275a provides a maintained contact closure output between P8 pins 12 and 14 as long as an arc is maintained between the torch and the workpiece. The motion contacts are rated for .6A - 125VAC / .6A - 110VDC / 2A - 30VDC.

Remote On/Off Input

- The Spirit275a requires a maintained contact closure between P8 pins 5 and 6 to energize the system from a remote location, provided that the emergency stop button on the front panel is not activated. Opening the contacts deenergizes the system. If the remote on/off feature is not used, install a jumper between terminal block TB1 positions 7 and 8. The contacts should be rated for 24VAC – 115mA.

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Power Supply Ready Output

- The Spirit275a provides a maintained contact closure output between P8 pins 7 and 8 when the system is ready to cut or mark. The contacts are open during gas purge or when an error occurs. The contacts are rated for .6A - 125VAC / .6A - 110VDC / 2A - 30VDC.

RS-422 Serial Communication Link

- An RS-422 serial communication link can be connected between the plug on the rear of the automatic gas console and a CNC machine or automatic height control system. All process parameters can be controlled via the RS-422 communication link. Also, cutting or marking information such as initial height, cutting or marking height, recommended arc voltage, and recommended travel speed can be transmitted from the automatic gas console to the CNC machine or height control. See Section 6 for additional information.

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Torch Coolant Requirements

Note: Refer to the supplier's most current Material Safety Data Sheet for information regarding safety, handling, and storage of torch coolant.

The Spirit275a system is shipped without torch coolant in the reservoir. **Coolant must be added before applying power to the system.** Only use Kaliburn approved torch coolant solution for optimal system performance as commercially available antifreeze contains corrosion inhibitors that will damage the cooling system. The standard coolant solution consists of 25% industrial grade propylene glycol and provides freezing protection down to -13º C (9º F). The standard solution can be ordered in one-gallon containers, PN 500695. For operating temperatures below -13º C, a 50% solution of industrial grade propylene glycol can be ordered in one-gallon containers, PN 500895, providing protection down to -36º C (-33º F).

Failure to use the proper propylene glycol solution may result in cooling system and/or torch damage.

The torch coolant should be flushed out of the Spirit system every six months and replaced with new coolant. The water filter/deionization cartridge should also be changed at the same time. See Section 7 for details.

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Initial Filling of the Torch Coolant Reservoir

Note: Never turn on the power supply before filling the torch coolant reservoir with the proper coolant solution.

When handling coolant, it is recommended that you wear nitrile gloves and safety glasses.

1. Remove the coolant reservoir cap and fill the reservoir with 2 gallons of coolant solution.

2. Apply main power to the Spirit unit.

3. Depress and hold the green ON button on the Spirit control panel.

4. The coolant pump will begin pumping coolant fluid through the system. The Coolant Flow LED will remain out until the coolant has filled the entire system and begins flowing back into the tank. The coolant pump will turn off if the coolant level drops below the minimum level inside the reservoir. If this happens, add more coolant solution to the reservoir and return to Step 3.

5. When the Coolant Flow LED illuminates, release the green ON switch. The Spirit system should remain energized and continue pumping coolant through the system.

6. Locate the small red push-button on top of the coolant filter/deionization cartridge. Depress and hold the button until no air is seen inside the clear filter housing.

7. Fill the reservoir with coolant solution until the coolant gauge indicates full. Coolant should be added to the system any time the level drops below half full.

8. Check for coolant leaks at all hose connections inside the power supply, RHF console, and at the torch.

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Section 4 Operation

Power Supply Front Panel Controls

All of the Spirit controls and status indicator lights are located on the front panel of the system as shown below. This section describes the function of each control and indicator.

Power Off Button (1)
Deenergizes the Spirit system and turns off the cooling fans and coolant pump.

Power On Button/Indicator (2)
Energizes the Spirit system and turns on the cooling fans and coolant pump. Also illuminates to show that the system is energized.

AC Power Indicator (3)
Illuminates when 3 phase power is applied to the Spirit system.

DC Power Indicator (4)
Illuminates when the main contactor has been energized and D.C. current is flowing through the torch.

Status Indicators (5)

- **RHF Door Indicator**
  Illuminates when the RHF console door is closed securely. Remains extinguished when the RHF console door is open.

- **Gas Console Indicator**
  Illuminates when the automatic gas console is operational. Remains extinguished when there is a problem with the gas system. Check the message screen on the automatic gas console for errors.

- **3 Phase Power Indicator**
  Illuminates when 3 phase power is satisfactory. Remains extinguished when there is a problem with main 3 phase power to the system.

- **Coolant Flow Indicator**
  Illuminates when the coolant flow through the system is satisfactory. Remains extinguished when the coolant flow through the system is restricted.

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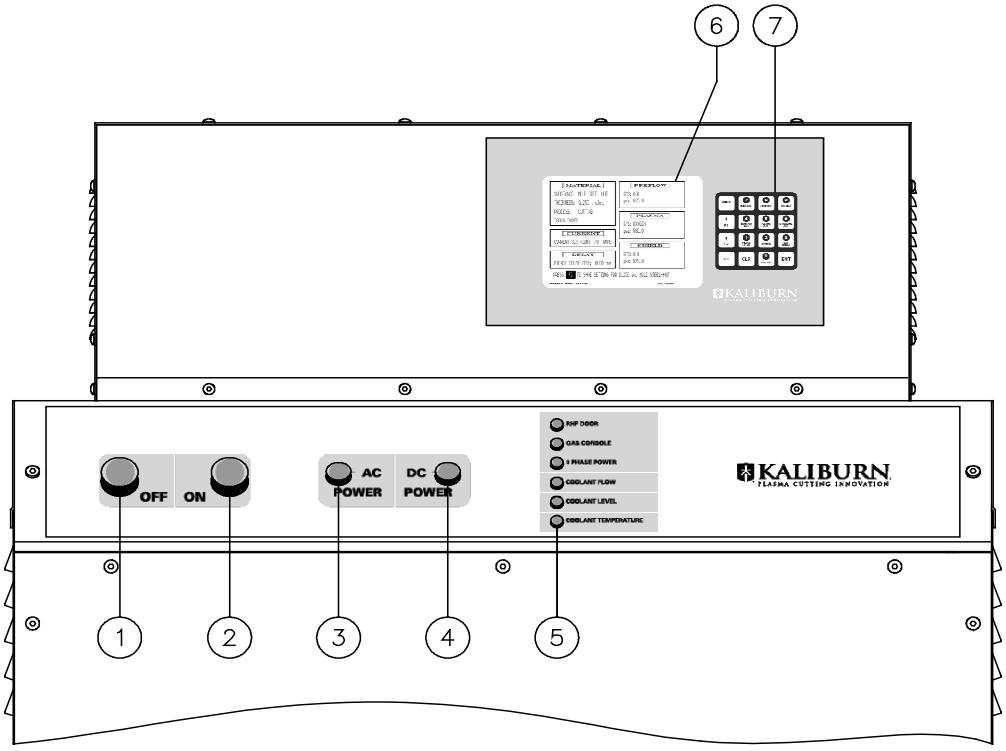
- **Coolant Level Indicator**
  Illuminates when the coolant level inside the reservoir is satisfactory. Remains extinguished when coolant must be added to the system.

- **Coolant Temperature Indicator**
  Illuminates when the torch coolant temperature is satisfactory. Remains extinguished when the coolant temperature is too hot. If the torch coolant indicator goes out, leave the unit energized until it illuminates.

Automatic Gas Console Display (6)
Shows all of the power supply and gas console settings, errors, and sequencing.

Automatic Gas Console Keypad (7)
Operator interface to automatic gas console.



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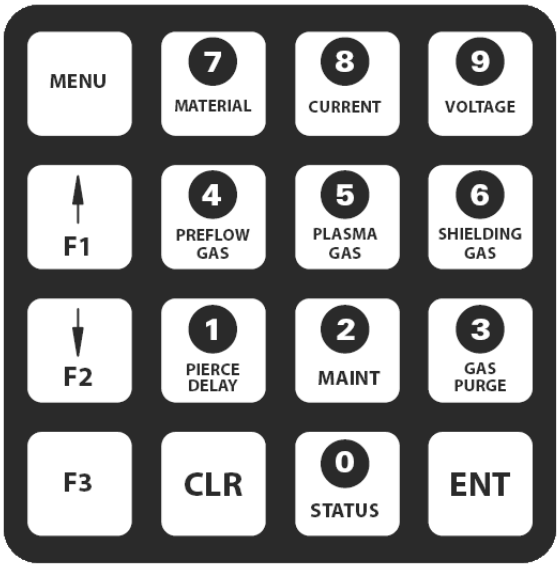
Automatic Gas Console Keypad

All cutting information is entered on the keypad of the automatic gas console as shown below. This section provides a description of each key and its function.



Menu Key

The Menu key is used to select the bottom portion of a split-level key. When the Menu key is pressed, a menu icon will appear in the upper right hand corner of the screen. Pressing the Menu key again will clear the icon and return to the previous mode. Pressing a split-level key while the menu icon is visible will enter the specified mode. The following is a list and description of menu key functions:

Menu + Material:	Enters the material editing mode
Menu + Current:	Enters the current editing mode
Menu + Voltage:	Displays the voltage screen
Menu + Preflow Gas:	Enters the preflow gas editing mode
Menu + Plasma Gas:	Enters the plasma gas editing mode
Menu + Shield Gas:	Enters the shield gas editing mode
Menu + Pierce Delay:	Enters the pierce time editing mode
Menu + Maint:	Enters the maintenance mode
Menu + Gas Purge:	Purges the cutting gases
Menu + Status:	Displays the main status screen

Arrow Keys

The Arrow keys are used to scroll up and down in order to edit or select a particular item.

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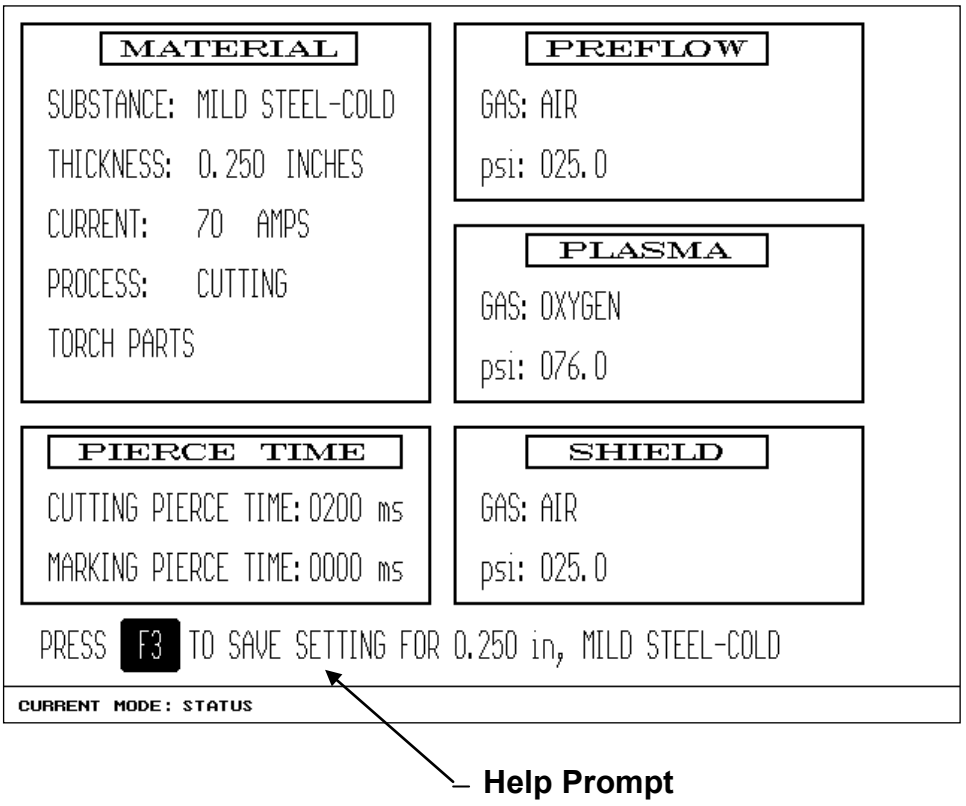
Function Keys
The Function keys are used for various purposes in the editing and maintenance modes. The help prompt instructs the user on the use of the Function keys.

Numerical Keys
The Numerical keys are used for entering and editing parameters.

Automatic Gas Console Help Prompt

Help prompts are displayed on the automatic gas console screen to assist the user. Different screens may have more than one help prompt, but the help prompts will always appear near the bottom of the screen.



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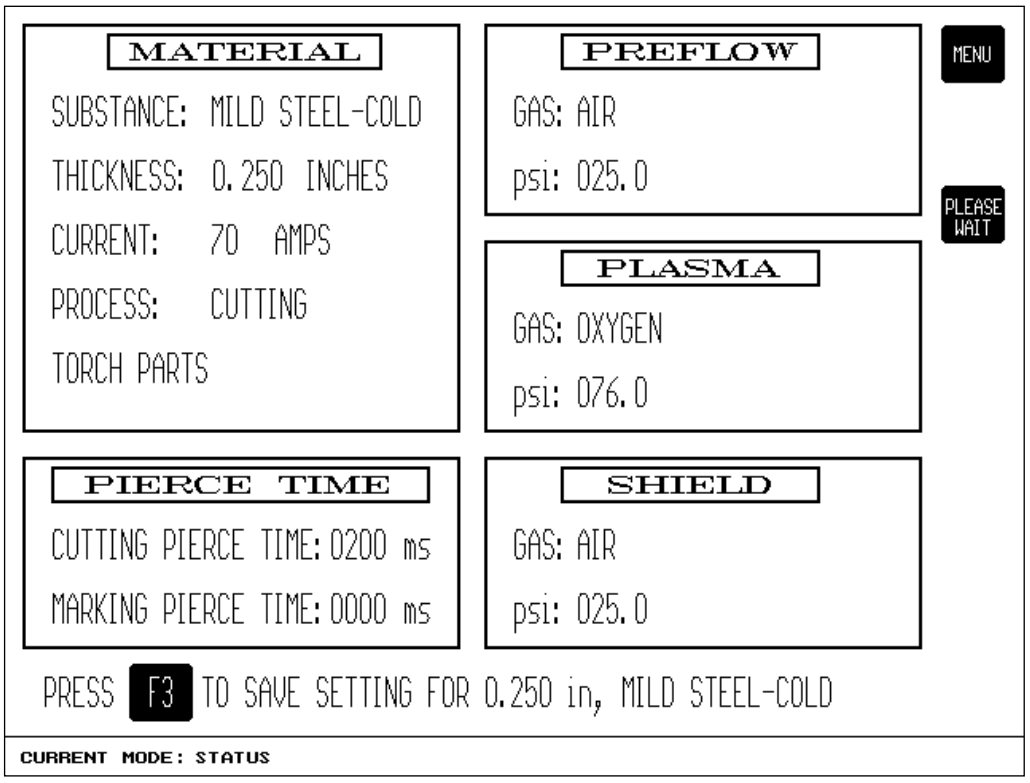
Automatic Gas Console Status Screen

When the automatic gas console is in the status mode, the status screen is displayed as shown. The status screen displays all of the primary cutting or marking parameters. To edit a parameter on the status screen, the arrow keys can be used to scroll through the different parameters or the Menu key can be used as described previously. Note that when the Menu key is pressed, the Menu icon appears in the upper right hand corner of the screen as shown. To return to the status mode from another mode, press the Menu key then the Status key. The status screen also displays the Please Wait icon while the gas pressures are being adjusted or when an error occurs with the gas system.



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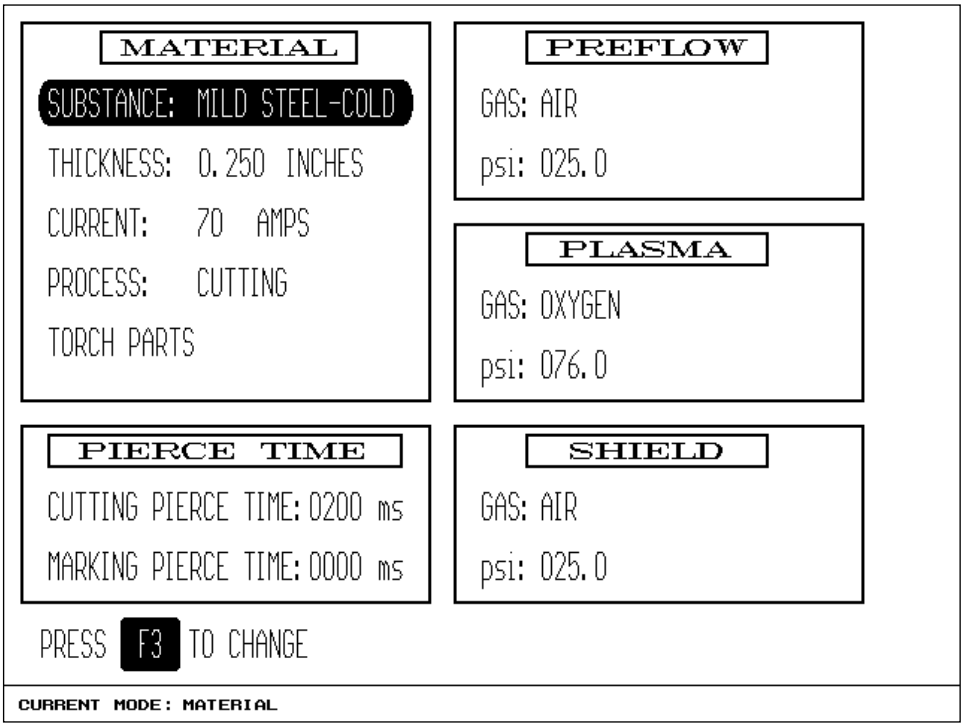
Setting up a Cut or Mark

The automatic gas console makes it very simple to set up the machine. Material type, material thickness, and process (cutting or marking) are the only parameters that must be set. All other parameters are adjusted automatically. Perform the following steps to enter the data. See Section 5 for advanced functions of the automatic gas console.

Selecting Material Type

From the status mode, press the down arrow once to scroll down to substance, or press Menu, then Material. The substance area should be highlighted as shown below and the substance type should be blinking. To change the substance type, press F3 as indicated by the help prompt. Pressing F3 repeatedly will scroll through the list of possible substance choices. The available substance types are as follows:

- Mild Steel - Cold Rolled
- Mild Steel - Hot Rolled
- Stainless Steel
- Aluminum
- Other



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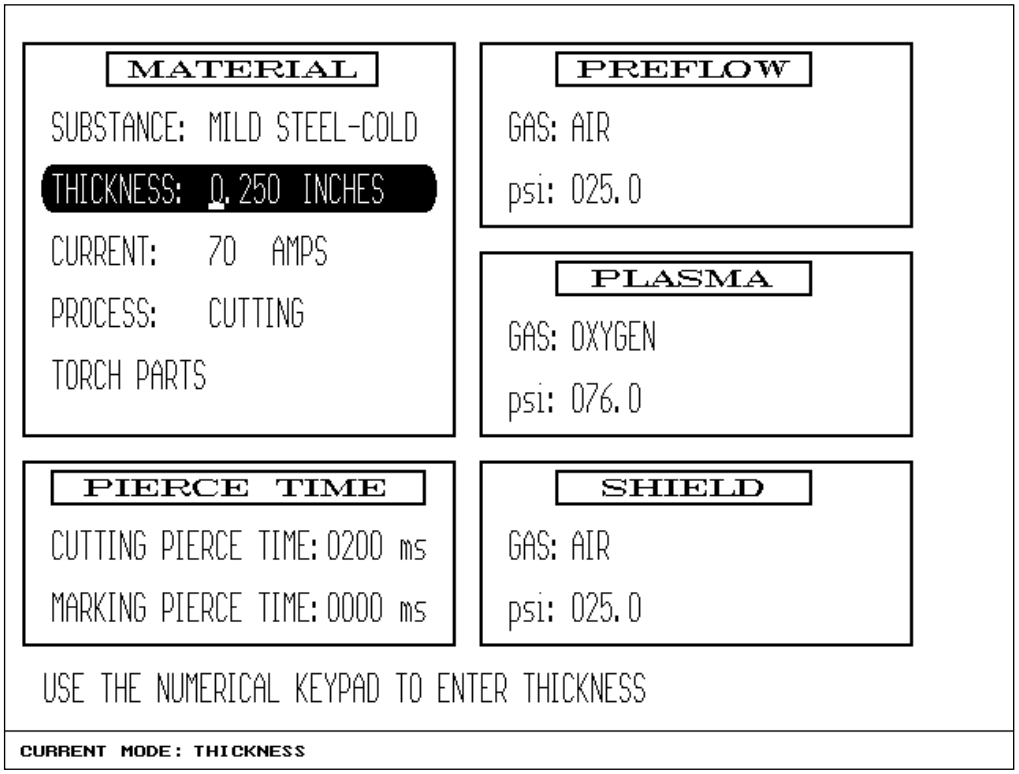
Setting Material Thickness

To set the material thickness, use the down arrow to scroll down to Thickness. The material thickness should be highlighted as shown below and the editing cursor should be blinking. Use the numerical keypad to enter the material thickness. Use the CLR key to backspace if an error is made. Press the enter key when the correct value has been entered.



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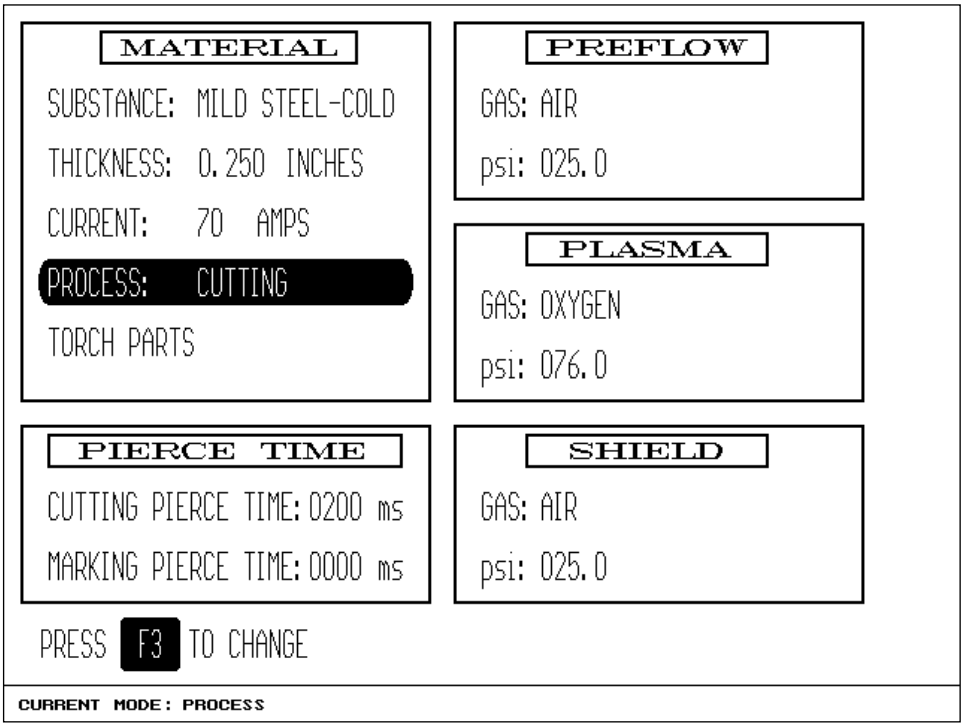
Selecting Process

The Spirit system has the capability of plasma cutting and plasma marking with the same set of consumables. The process (cutting or marking) can be set by the RS-422 serial interface, by a hard signal on the CNC interface plug, or locally at the automatic gas console. See Section 5, Automatic Gas Console Advanced Functions, for instructions on setting up how switching between cutting and marking is performed. To set the operating process, use the down arrow to scroll down to Process. The process area should be highlighted as shown below and the process should be blinking. To change the process, press F3 as indicated by the help prompt. Repeatedly pressing F3 will alternate between cutting and marking. Press the enter key when the desired process has been selected. At this point, the default parameters are selected and adjusted automatically for the material type, material thickness, and process selected. Note that the CNC machine can override the selected process unless the cut/mark/cut configuration is set to Local.



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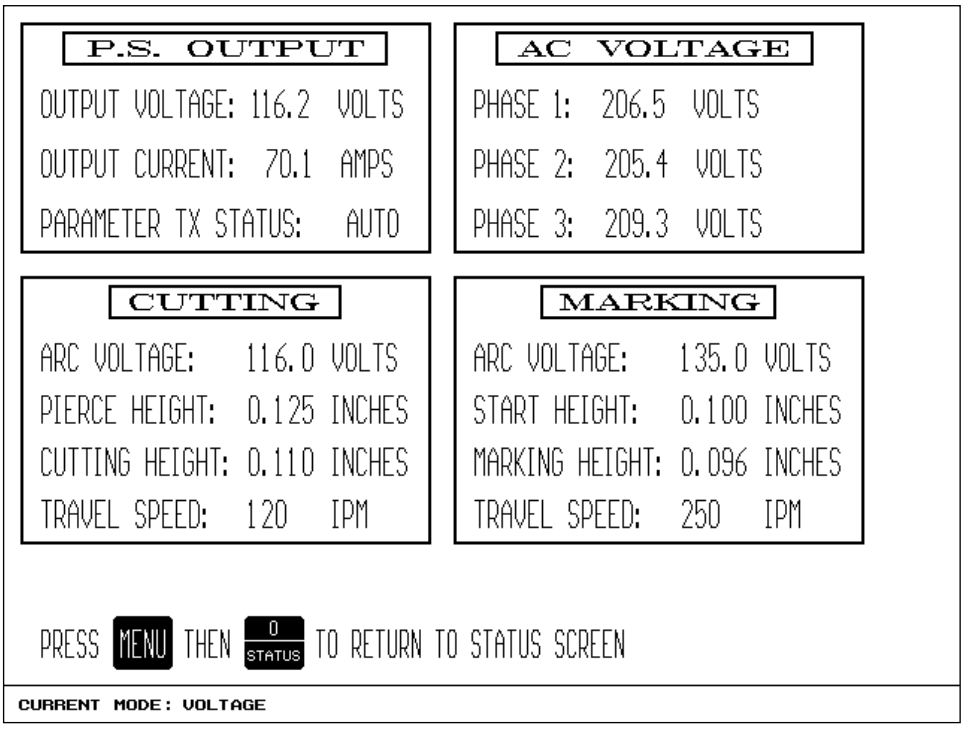
Viewing Recommended Height Control and X/Y Machine Settings

Prior to making a cut or mark with the system, the torch height control and the x/y cutting machine must be configured properly. To view the recommended cutting data, press the Menu key, then Voltage. The voltage screen will be displayed as shown. The x/y machine speed should be set to the value shown. Also, the height control should be set to the proper pierce (initial) height, cutting (marking) height and arc voltage. If a KALIBURN Inova height control is being used, simply press the F3 key to automatically transmit the parameters to the Inova. Optionally, the Spirit system can be set to automatically send the cutting/marking parameters. See Section 5 for information on configuring the Inova height control parameter transmit feature.



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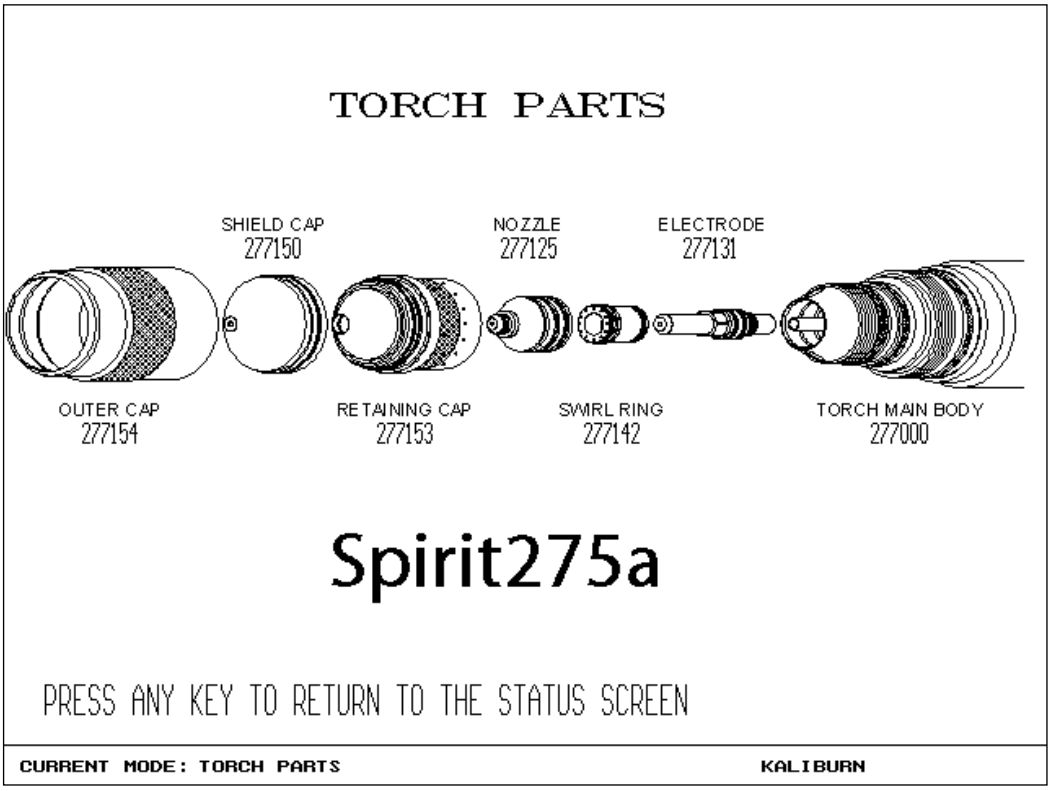
Viewing the Torch Parts Required

Once the material substance and thickness have been chosen, the default cutting parameters are selected and adjusted accordingly. To display a pictorial view of the torch parts required to make the cut or mark, scroll down to Torch Parts and press enter. An example of the torch parts screen is displayed below.



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Torch Consumable Selection

Mild Steel
Copper Electrode

	Outer Retaining Cap	Shield Cap	Inner Retaining Cap	Nozzle	Swirl Ring	Copper Electrode	Torch Head
30A	277154	277145	277153	277120	277140	277130	279150
50A	277154	277115	277153	277122	277140/ 277142	277131	279150
70A	277154	277150	277153	277125	277142	277131	279150
100A	277154	277286	277151	277284	277283	277282	279150
150A	277154	277117	277151/ 277152	277293	277139	277292	279150
200A	277154	277274	277266	277289	277143	277291	279150
275A	277154	277263	277266	277269	277258	277270	279150

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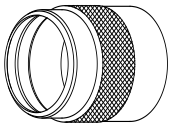
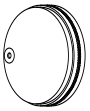
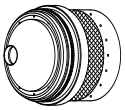
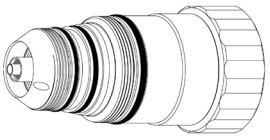
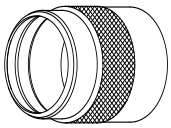
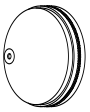
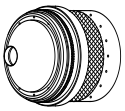
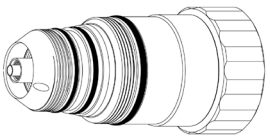
Mild Steel
Silver Electrode

	Outer Retaining Cap	Shield Cap	Inner Retaining Cap	Nozzle	Swirl Ring	Silver Electrode	Torch Head
200A	277154 	277274 	277266 	279489	279443	279440 (yellow o-ring)	279160 
275A	277154 	277263 	277266 	279469	279458	279450 (red o-ring)	279160 

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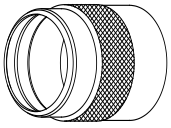
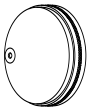
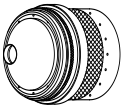
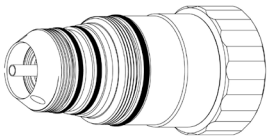
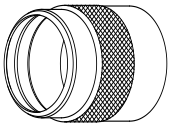
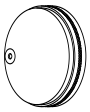
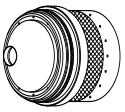
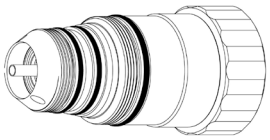
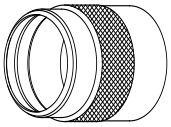
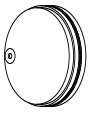
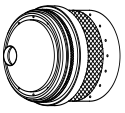
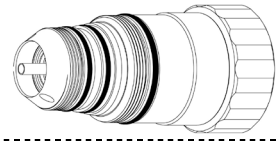
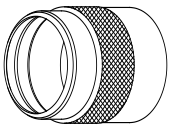
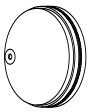
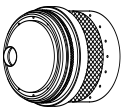
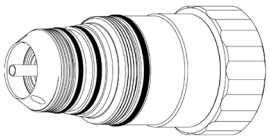
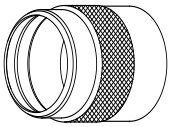
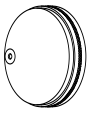
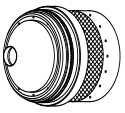
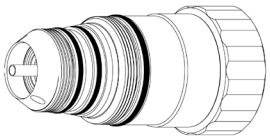
Stainless Steel - H17 Plasma
Copper Electrode

	Outer Retaining Cap	Shield Cap	Inner Retaining Cap	Nozzle	Swirl Ring	Copper Electrode	Torch Head
	277154	277150	277113	277124	277140	277132	279150
70A							
	277154	277146	277113	277126	277141	277133	279150
100A							
	277154	277298	277266	277297	277139	277135	279150
150A							
	277154	277274	277266	277287	277259	277135	279150
200A							
	277154	277211	277280	277118	277139	277135	279150
260A							

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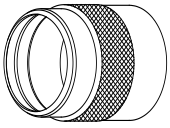
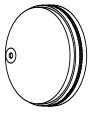
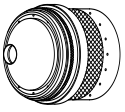
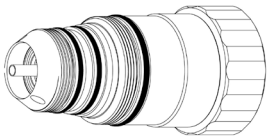
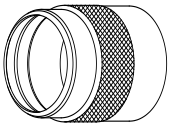
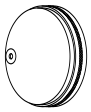
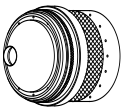
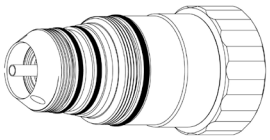
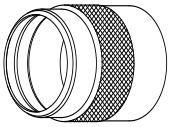
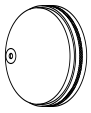
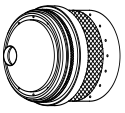
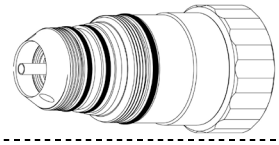
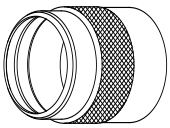
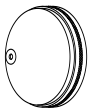
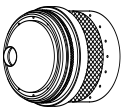
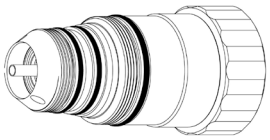
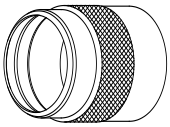
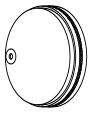
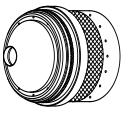
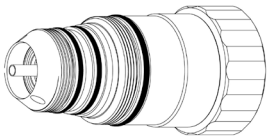
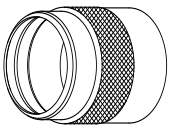
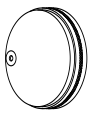
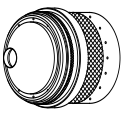
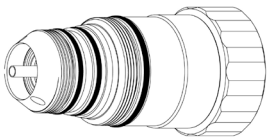
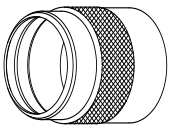
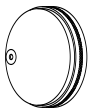
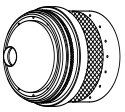
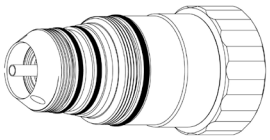
Stainless Steel - Air or Nitrogen Plasma
Copper Electrode

	Outer Retaining Cap	Shield Cap	Inner Retaining Cap	Nozzle	Swirl Ring	Copper Electrode	Torch Head
	277154	277144	277110	277121	277138	277137	279150
30A							
	277154	277149	277110	277123	277142	277137	279150
50A							
	277154	277150	277153	277125	277142	277131	279150
70A							
	277154	277286	277151	277284	277283	277282	279150
100A							
	277154	277117	277152	277293	277139	277292	279150
150A							
	277154	277274	277266	277289	277143	277291	279150
200A							
	277154	277263	277266	277276	277258	277270	279150
275A							

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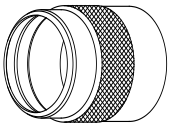
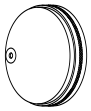
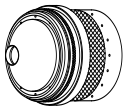
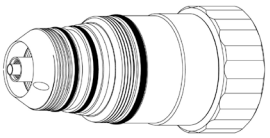
Stainless Steel - Air or Nitrogen Plasma
Silver Electrode

	Outer Retaining Cap	Shield Cap	Inner Retaining Cap	Nozzle	Swirl Ring	Silver Electrode	Torch Head
	277154	277274	277266	279489	279443	279440 (yellow o-ring)	279160
200A							

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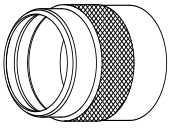
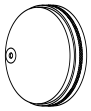
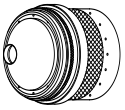
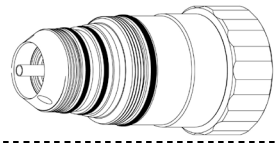
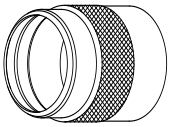
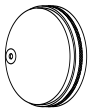
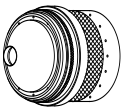
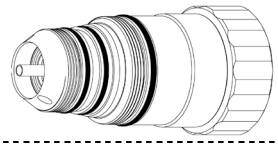
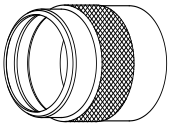
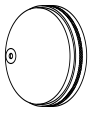
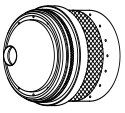
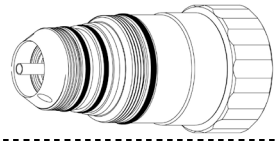
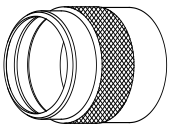
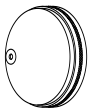
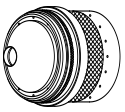
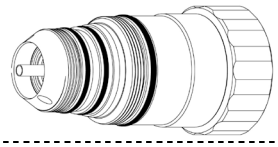
Aluminum
Copper Electrode

	Outer Retaining Cap	Shield Cap	Inner Retaining Cap	Nozzle	Swirl Ring	Copper Electrode	Torch Head
	277154	277145	277153	277120	277140	277130	279150
30A							
	277154	277150	277153	277122	277142	277131	279150
50A							
	277154	277150	277153	277125	277142	277131	279150
70A							
	277154	277286	277151	277284	277283	277282	279150
100A							
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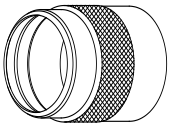
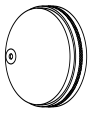
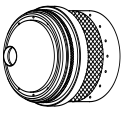
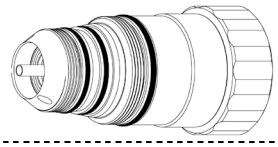
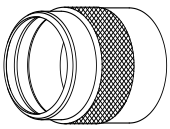
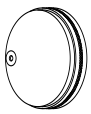
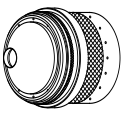
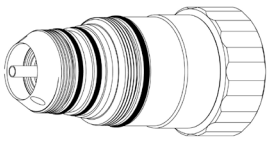
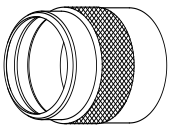
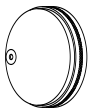
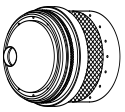
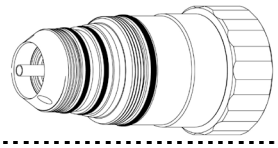
150A							
	277154	277274	277266	277289	277143	277291	279150
200A							
	277154	277263	277266	277276	277258	277270	279150
275A							

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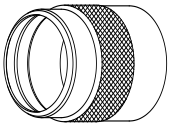
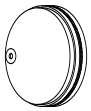
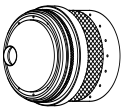
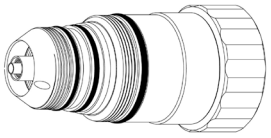
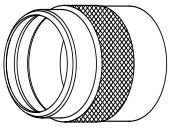
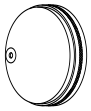
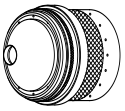
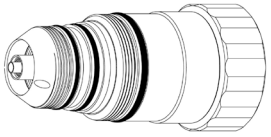
Aluminum
Silver Electrode

	Outer Retaining Cap	Shield Cap	Inner Retaining Cap	Nozzle	Swirl Ring	Silver Electrode	Torch Head
200A	277154 	277274 	277266 	279489	279443	279440 (yellow o-ring)	279160 
275A	277154 	277263 	277266 	279469	279458	279450 (red o-ring)	279160 

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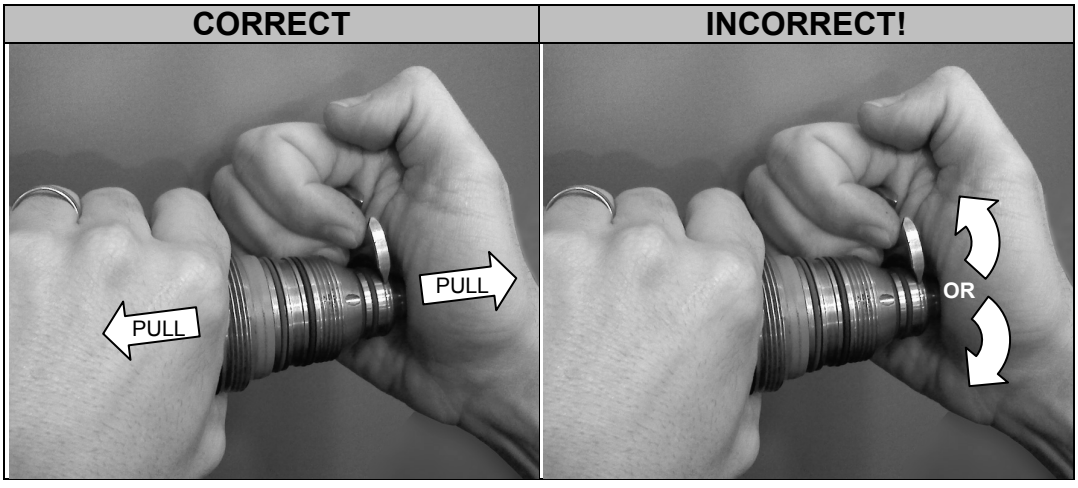
Installing and Removing Torch Consumables

⚠ **Turn off the plasma power supply before continuing with this procedure.**

Note: When installing the consumables, do not use an excessive amount of o-ring lubricant. Also ensure that the lubricant is placed only on the o-rings. Excess lubricant can interfere with gas flow, which can cause starting problems, poor cut quality, and short consumable life.

Note: Do not over tighten the consumables! Only tighten until the parts are seated properly.

1. Unthread the quick-disconnect torch head from the torch base by turning the attachment ring to the RIGHT.
2. Remove the outer retaining cap from the torch head.
3. Remove the inner retaining cap from the torch head.
4. Separate the shield cap from either the inner retaining cap or the outer retaining cap.
5. Use the nozzle removal tool (P/N 277056) to remove the nozzle from the torch head. To do this, insert the tool into the groove on the nozzle and hold the tool/nozzle in the palm of your hand. Pull both hands apart using a linear motion as in the left image below. Do not use a prying or bending motion as in the right image below.



6. Use the swirl ring removal tool (P/N 260105) to remove the swirl ring from the nozzle.

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7. If using a copper electrode, use the tool (P/N 277087) to remove the electrode from the torch head. If using a silver electrode, use the tool (P/N 279061) to remove the silver electrode from the torch head.
8. Inspect all consumables and o-rings for damage and excess wear. Exchange for new consumables as necessary.
9. Inspect the cooling tube in the torch head for damage. See Section 7 Maintenance and Troubleshooting if replacement is necessary.

Making a Cut or Mark

Once the material type, thickness, and process have been entered, the correct torch parts are installed, and the x/y machine and height control systems have been properly configured, perform the following steps to cut or mark with the system:

1. Depress and hold the Power On button until the Coolant Flow status LED illuminates. If the Coolant Flow led fails to illuminate after 10 seconds, see the maintenance section for possible solutions.
2. The automatic gas console will purge the gas hoses and set the correct gas pressures automatically. After the pressures have been set correctly, the Gas Console status LED will illuminate.
3. Once the Gas Console LED illuminates, the unit is ready for cutting or marking. Upon the reception of a cycle start signal, the following sequence will take place:
   - Two second gas preflow
   - High frequency starting circuit energized
   - Pilot arc initiation
   - Transferred arc (cutting or marking arc) established
   - Motion output relay energized
4. Upon removal of the cycle start signal, the arc will be extinguished and the motion output relay will be deenergized.

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Piercing Thick Materials

Care must be taken when piercing thick materials in order to prevent damage to the shield cap and nozzle. As with all thicknesses, the pierce height must be set high enough so the metal ejected while piercing does not come into contact with the shield cap. Also, some of the material ejected during the pierce may adhere to the top side of the plate and form a ring of solidified material around the pierce point. Action must be taken so the torch does not move from the pierce height down to the cutting height and come into contact with this solidified metal. The torch should not move from the pierce height down to the cutting height until the x/y machine has moved the torch away from the pierce point. One way to accomplish this may be to program the pierce time on the torch height control system to a value that is longer than the x/y machine motion delay time. On very thick materials, an edge start or moving pierce may be required to prevent damage to the torch consumables. With a moving pierce, the x/y machine should begin moving at approximately 5–10 inches/minute (125–250 mm/min) as soon as the arc transfers to the plate. After the arc completely penetrates the plate, the torch should be positioned at the proper cutting height and the x/y machine speed should be increased to the correct level. With an edge start, the torch should be positioned at the edge of the material prior to starting the arc.

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Cut Quality

Before the optimum cutting condition can be achieved on a particular material type and thickness, the machine operator must have a thorough understanding of the cutting characteristics of the Spirit system. When the cut quality is not satisfactory, the cutting speed, torch height, or gas pressures may need to be adjusted in small increments until the proper cutting condition is obtained. The following guidelines should be useful in determining which cutting parameter to adjust.

Note: Before making any parameter changes, verify that the torch is square to the workpiece. Also, it is essential to have the correct torch parts in place and to ensure that they are in good condition. Check the electrode for excessive wear and the nozzle and shield cap orifices for roundness. Also, check the parts for any dents or distortions. Irregularities in the torch parts can cause cut quality problems.

1. A positive cut angle (top dimension of piece smaller than the bottom dimension) usually occurs when the torch standoff distance is too high, when cutting too fast, or when excessive power is used to cut a given plate thickness.
2. A negative cut angle (top dimension of piece larger than the bottom dimension) usually occurs when the torch standoff distance is too low or when the cutting speed is too slow.
3. Top dross usually occurs when the torch standoff distance is too high.
4. Bottom dross usually occurs when the cutting speed is either too slow (slow-speed dross) or too fast (high-speed dross). Low-speed dross is easily removed, while high-speed dross usually requires grinding or chipping off. When using oxygen as the shielding gas, bottom dross can sometimes be removed by increasing the shield gas pressure. However, increasing the shield pressure too much can cause cut face irregularities (see below). Bottom dross also occurs more frequently as the metal heats up. As more pieces are cut out of a particular plate, the more likely they are to form dross.
5. When using oxygen as a shielding gas, cut face irregularities usually indicate that the shield gas pressure is too high or the torch standoff distance is too low.
6. A concave cut face usually indicates that the torch standoff distance is too low or the shield gas pressure is too high. A convex cut face usually indicates that the torch standoff distance is too high or the shield gas pressure is too low.
7. Note that different material compositions have an effect on dross formation.
8. If the material is not being completely severed, the likely causes are that the cutting current is too low, the travel speed is too high, the gas pressures are incorrect, the incorrect gas types are selected, the incorrect consumables are installed in the torch, or the consumables are worn.

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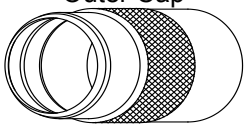
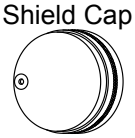
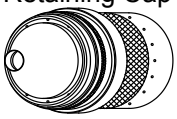
Changing Consumable Parts

When the cut quality is not satisfactory, use the following guidelines for determining which consumable parts need to be changed. Inspect all parts for dirt, debris, and excess o-ring lubricant and clean as necessary.

Part	Inspect For	Corrective Action
Outer Cap 	Dents, cracks	Replace outer cap
Shield Cap 	Center hole out of round	Replace shield cap
	Dents, Scratches	Replace shield cap
	Dry o-ring	Apply a thin film of o-ring lubricant
	Damaged o-ring	Replace shield cap
Retaining Cap 	Center hole out of round	Replace retaining cap
	Dents, cracks	Replace retaining cap
	Dry o-ring	Apply a thin film of o-ring lubricant
	Damage o-ring	Replace retaining cap
Nozzle	Center hole out of round	Replace nozzle
	Erosion or arcing	Replace nozzle
	Dry o-rings	Apply a thin film of o-ring lubricant
	Damaged o-rings	Replace nozzle
Swirl Ring	Damage	Replace swirl ring
	Clogged holes	Blow out with compressed air. Replace swirl ring if clogs can't be removed.
	Dry o-rings	Apply a thin film of o-ring lubricant
	Damaged o-rings	Replace swirl ring
Electrode	Pit depth	Replace electrode if center pit depth is greater than .040" (1 mm)
	Erosion or arcing	Replace electrode
	Dry o-rings	Apply a thin film of o-ring lubricant
	Damaged o-rings	Replace electrode

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Consumable Life

Use the following guidelines to maximize consumable parts life:

1. The Spirit system utilizes the latest advancement in technology for extending the life of the torch consumable parts. To maximize the life of the consumable parts, it is imperative that the shutdown procedure of the arc is carried out properly. **The arc must be extinguished while it is still attached to the workpiece.** A popping noise may be heard if the arc extinguishes abnormally. Note that holes are usually programmed without lead-outs to prevent loss of the arc during shutdown. There is a time delay between the reception of a stop signal and when the arc is extinguished. During this time, the gases and cutting current are changed to optimum values for extinguishing the arc. Ideally, the x/y machine controller should provide a plasma stop signal prior to the end of the cut path so the gases and current reach the shut off values at the same time that the part has been completely cut. The shut down times are different for each current and are given below.

Arc Shutdown Times

Current (A)	Time (ms)
30	490
50	390
70	300
100	300
150	175
200	195
260	175
275	175

2. Use the recommended pierce height given in the cutting charts. A pierce height that is too low will allow molten metal that is ejected during the piercing process to damage the shield cap and nozzle. A pierce height that is too high will cause the pilot arc time to be excessively long and will cause nozzle damage.
3. Never fire the torch in the air. Nozzle damage will occur.
4. Make sure the torch does not touch the plate while cutting. Shield cap and nozzle damage will result.
5. Use a chain cut when possible. Starting and stopping the torch is more detrimental to the consumables than making a continuous cut.
6. Always use the error tracking feature on the automatic gas console to keep track of cut errors. See Section 5 for information on the error tracking feature.

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Cutting Charts

The cutting charts shown on the following pages are intended to give the operator the best starting point to use when making a cut on a particular material type and thickness. Small adjustments may have to be made to achieve the best cut. Also, remember that the arc voltage must be increased as the electrode wears in order to maintain the correct cutting height.

Cutting Chart Index

Material	Current	Plasma Gas	Shield Gas	Copper Electrode	Silver Electrode
Mild Steel	30 Amps	Oxygen	Oxygen	Page 4-25	
Mild Steel	50 Amps	Oxygen	Oxygen or Air	Page 4-26	
Mild Steel	70 Amps	Oxygen	Air	Page 4-27	
Mild Steel	100 Amps	Oxygen	Air	Page 4-28	
Mild Steel	150 Amps	Oxygen	Air	Page 4-29	
Mild Steel	200 Amps	Oxygen	Air	Page 4-30	Page 4-51
Mild Steel	275 Amps	Oxygen	Air	Page 4-31	Page 4-52
Stainless Steel	30 Amps	Air	Air	Page 4-32	
Stainless Steel	50 Amps	Air	Nitrogen	Page 4-33	
Stainless Steel	70 Amps	H17	Nitrogen	Page 4-34	
Stainless Steel	70 Amps	Air	Nitrogen	Page 4-35	
Stainless Steel	100 Amps	H17	Nitrogen	Page 4-36	
Stainless Steel	100 Amps	Air	Nitrogen	Page 4-37	
Stainless Steel	150 Amps	H17	Nitrogen	Page 4-38	
Stainless Steel	150 Amps	Air	Nitrogen	Page 4-39	
Stainless Steel	200 Amps	H17	Nitrogen	Page 4-40	
Stainless Steel	200 Amps	Air	Nitrogen	Page 4-41	Page 4-53
Stainless Steel	260 Amps	H17	Nitrogen	Page 4-42	
Stainless Steel	275 Amps	Air	Nitrogen	Page 4-43	
Aluminum	30 Amps	Air	Nitrogen	Page 4-44	
Aluminum	50 Amps	Air	Nitrogen	Page 4-45	
Aluminum	70 Amps	Air	Nitrogen	Page 4-46	
Aluminum	100 Amps	Air	Nitrogen	Page 4-47	
Aluminum	150 Amps	Air	Nitrogen	Page 4-48	
Aluminum	200 Amps	Air	Nitrogen	Page 4-49	Page 4-54
Aluminum	275 Amps	Air	Nitrogen	Page 4-50	Page 4-55

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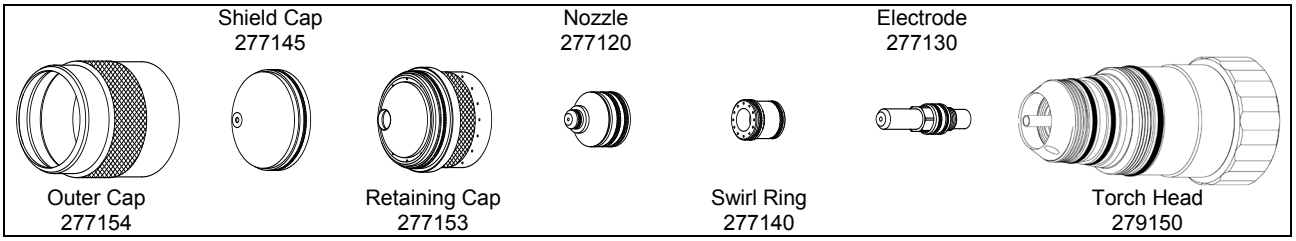
Mild Steel - 30 Amps - Oxygen Plasma / Oxygen Shield
Copper Electrode



Imperial

Material Thickness (ga)	Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
20	.036	35	85	6	84	120	105	.080	.110	100	.062
18	.048					121	97	.090			
16	.060					125	78	.105		200	.065
14	.075					126	65				
12	.105					127	55				.070
11	.120					129	50	.120	.125	300	
10	.135					131	40				

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
1	35	85	6	84	120	2615	2.0	2.8	100	1.6
1.5					124	2020	2.6		200	1.7
2					126	1615	2.7			
2.5						1455				1.8
3					128	1285	2.9	3.1	300	

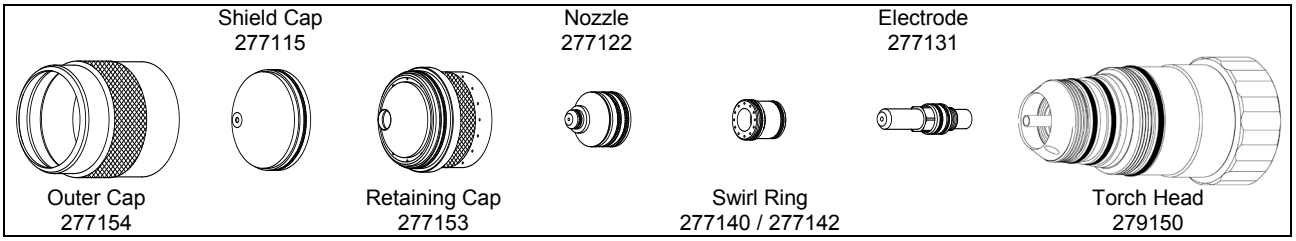
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	145	250	6350	.177	4.5	.100	2.5	0

1. Revised on 10/21/2009

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Mild Steel - 50 Amps - Oxygen Plasma / Oxygen or Air Shield
Copper Electrode



Imperial

Material Thickness (ga)	Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
Cold-Rolled Steel – Oxygen Shield – Swirl Ring 277140											
12	.105	25	74	12	73	123	70	.120	.135	100	.075
11	.120					126	60	.125		200	.078
10	.135					128	50	.135			
Hot-Rolled Steel – Air Shield – Swirl Ring 277142											
14	.075	25	74	19	73	106	200	.100	.135	100	.075
12	.105						190				
	.125						180			200	.080
10	.135					110	170	.110			
	3/16					113	105	.140	.200	300	.085
	1/4					117	75		.225	400	.087

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
Cold-Rolled Steel – Oxygen Shield – Swirl Ring 277140										
2.5	25	74	12	73	121	1895	2.9	3.4	100	1.9
3					125	1555	3.1		200	2.0
Hot-Rolled Steel – Air Shield – Swirl Ring 277142										
2.5	25	74	19	73	106	4885	2.5	3.4	100	1.9
3						4660			200	2.0
5					113	2555	3.6	5.1	400	2.2
6					116	2075		5.5		

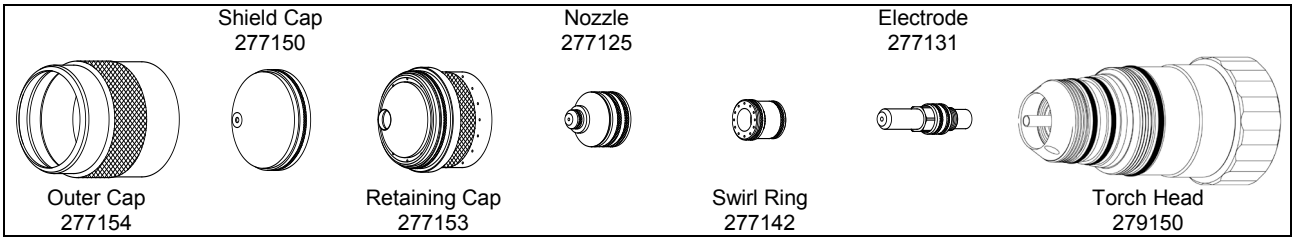
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	145	250	6350	.147	3.7	.100	2.5	0

1. Revised 10/21/2009

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Mild Steel - 70 Amps - Oxygen Plasma / Air Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/8	25	80	35	79	110	190	.100	.150	100	.080
3/16			40		113	130		.200	200	
1/4					116	120	.110	.225	300	.085
3/8					122	75	.140	.250	400	

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
3	25	80	35	79	109	4995	2.5	3.6	100	2.0
5			40		113	3265		5.1	300	
6					115	3105	2.7	5.5		2.2

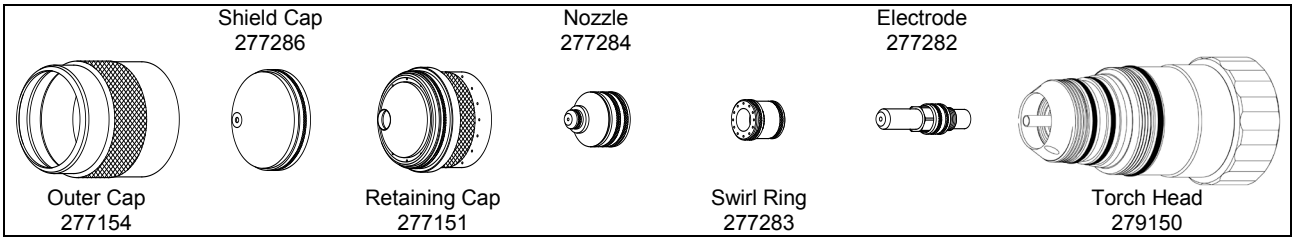
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	135	250	6350	.096	2.4	.100	2.5	0

1. Revised on 12/01/2009

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Mild Steel - 100 Amps - Oxygen Plasma / Air Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	25	94	26	93	125	150	.090	.200	300	.090
3/8					130	100	.130	.250	400	
1/2						65	.155	.300	500	
5/8					143	47	.185	.325	800	.095
3/4					145	35		.350	1000	

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	25	94	26	93	124	3950	2.1	4.9	300	2.3
10					130	2405	3.3	6.5	500	
12						1850	3.7	7.3		
16					143	1180	4.7	8.3	1000	2.4
20					145	800		9.0		

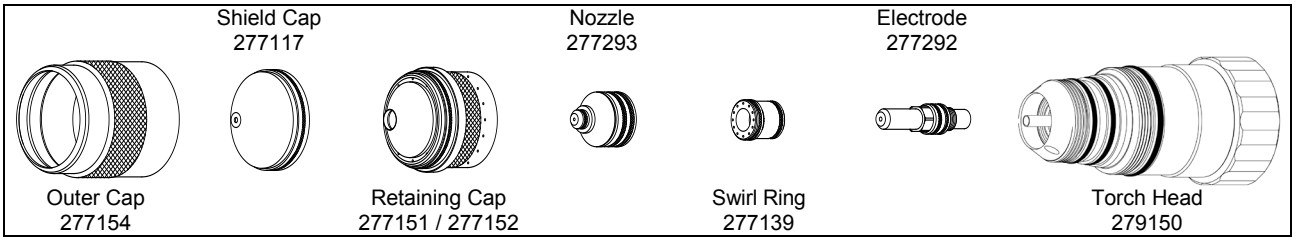
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	130	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
1. Revised on 10/21/2009

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Mild Steel - 150 Amps – Oxygen Plasma / Air Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
Retaining Cap 277151										
1/4	20	74	30	67	118	165	.105	.200	300	.125
3/8					123	125	.135	.250	400	
1/2					125	90	.140	.300	500	.130
Retaining Cap 277152										
5/8	20	74	45	67	127	70	.140	.325	600	.130
3/4					130	55		.350	1000	.135
1					134	40	.150	.400	1500	.140
1.25 **					145	25	.200	.350		
1.5 **					155	15	.225			

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
Retaining Cap 277151										
6	20	74	30	67	117	4305	2.6	4.9	300	3.2
10					123	3040	3.4	6.5	500	
12					124	2485	3.5	7.3		3.3
Retaining Cap 277152										
16	20	74	45	67	127	1760	3.6	8.3	1000	3.3
20					130	1340		9.0	1500	3.4
25					133	1040	3.7	10.1		3.6
32 **					145	625	5.1	8.9		
38 **					154	385	5.6	8.9		

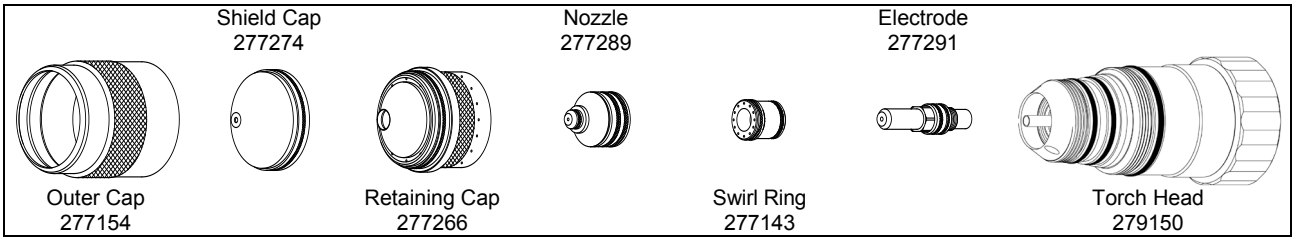
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	135	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
1. Revised on 12/01/09

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Mild Steel - 200 Amps – Oxygen Plasma / Air Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	20	82	58	75	125	230	.040	.200	300	.150
3/8					130	140	.090	.250	400	
1/2					133	120	.115	.300	500	
5/8					137	100	.130	.350	600	.152
3/4					140	75	.150	.400	800	.153
1					147	50	.175	.450	1000	.155
1.25					155	25	.240	.500	1500	
1.5 **					165	17	.300	.350		158
1.75 **					175	12	.350			
2.0 **					185	7	.500	.500		.160

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	20	82	58	75	124	6100	.8	4.9	300	3.8
10					130	3480	2.3	6.5	500	
12					132	3160	2.7	7.3		
16					137	2515	3.3	8.9	800	3.9
20					141	1810	3.8	10.3	1000	
25					146	1310	4.3	11.3		
32					155	610	6.1	12.7	1500	
38 **					164	435	7.5	8.9		4.0
45 **					175	295	9.2	9.2		
50 **					183	195	12.2	12.2		4.1

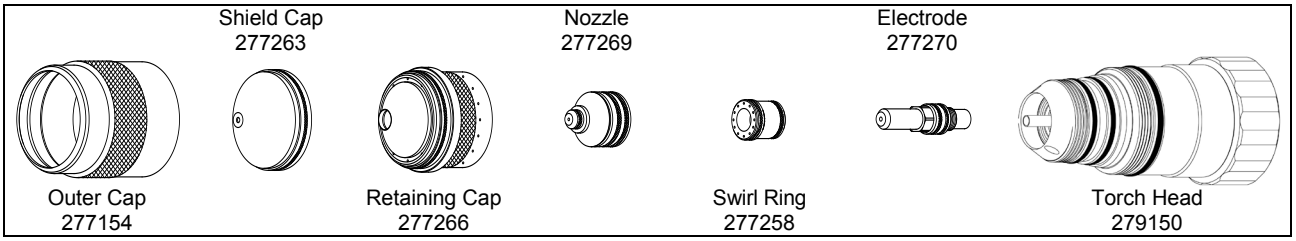
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	120	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised 12/01/09

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Mild Steel - 275 Amps - Oxygen Plasma / Air Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/2	20	93	70	83	139	125	.140	.300	500	.165
5/8						105	.135	.325	600	
3/4					138	90	.120	.350	800	.170
1					144	65	.160	.400	1000	.185
1.25					150	45	.175	.500	1500	
1.50 **					163	25	.235	.350		.190
1.75 **					170	20	.290			
2.00 **					180	15	.350			
2.25 **					185	13	.375	.375		.260
2.50 **					190	9	.385	.385		.275

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
12	20	93	70	83	139	3290	3.6	7.4	500	4.2
16					138	2650	3.3	8.3	800	
20						2190	3.1	9.0	1000	4.3
25					143	1690	4.0	10.1		4.7
32					150	1120	4.4	12.8	1500	
38 **					162	645	5.9	8.9		4.8
45 **					170	495	7.5			
50 **					178	395	8.7			
55 **					183	345	9.2	9.2		6.6
60 **					187	285	9.6	9.6		6.9

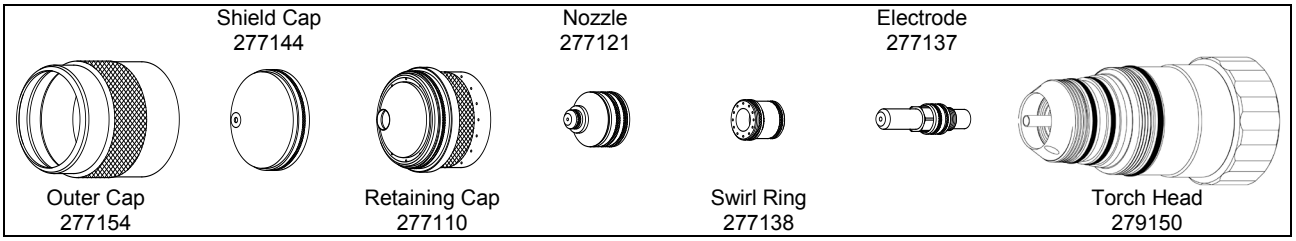
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	108	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .300" (7.6 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended.
(Revised 10/22/09)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 30 Amps - Air Plasma / Air Shield
Copper Electrode



Imperial

Material Thickness (ga)	Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
20	.036	30	80	30	80	71	200	.020	.050	100	.065
18	.048						165	.035			
16	.060					74	125			200	.068
14	.075					75	90	.025			.070

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
1	30	80	30	80	71	4855	0.6	1.3	100	1.7
1.5					73	3260	0.9		200	

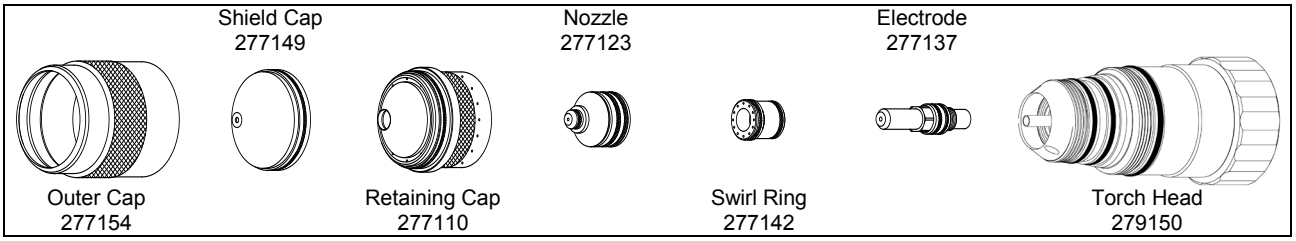
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	145	250	6350	.177	4.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .050" (1.3 mm) for cutting and .100" (2.5 mm) for marking
(Revised 12/1/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 50 Amps – Air Plasma / Nitrogen Shield
Copper Electrode



Imperial

Material Thickness (ga)	Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
14	.075	30	70	40	70	87	105	.035	.070	100	.105
12	.105					88	75				
11	.120					89	65			200	
10	.135					90	55				.110
	3/16					94	50	.040	.080	300	
	1/4					100	40	.060	.125	400	.115

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
2	30	70	40	70	87	2565	.9	1.8	100	2.7
2.5						2080				
3					88	1685			200	
5					94	1235	1.0	2.1	400	2.8
6					98	1075	1.3	2.9		2.9

Marking

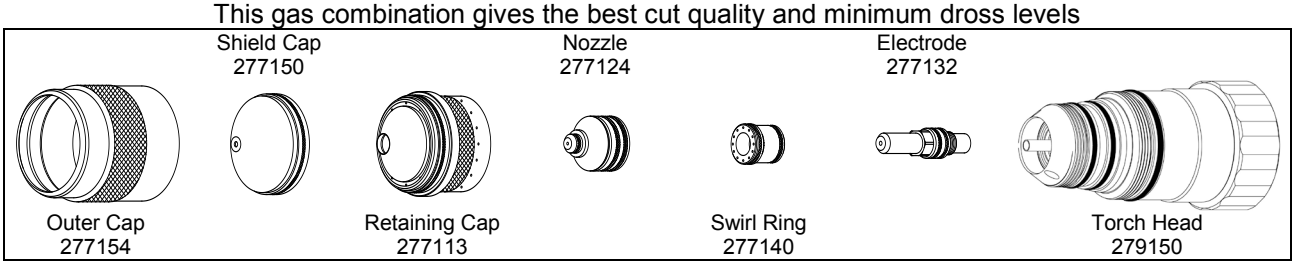
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	145	250	6350	.147	3.7	.100	2.5	0

* Use an arc transfer height (ignition height) of .070" (1.8 mm) for cutting and .100" (2.5 mm) for marking
(Revised 10/21/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 70 Amps - H17 Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives the best cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
3/16	35	60	36	60	135	80	.100	.200	300	.090

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
5	35	60	36	60	135	2030	2.5	5.1	300	2.3

Marking

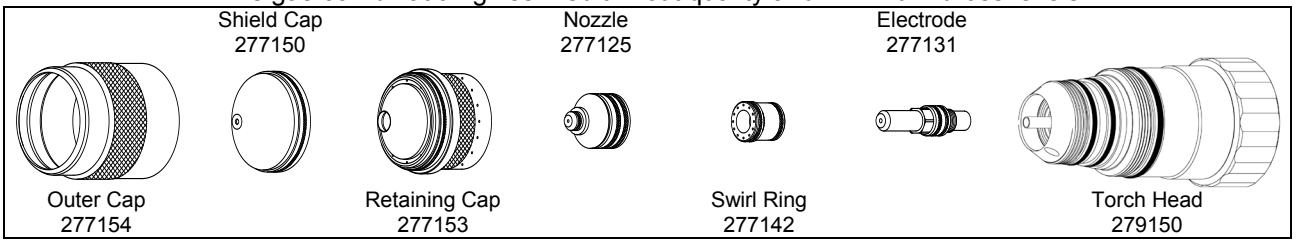
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	135	250	6350	.096	2.4	.100	2.5	0

* Use an arc transfer height (ignition height) of .150" (3.8 mm) for cutting and .100" (2.5 mm) for marking
(Revised 12/1/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 70 Amps - Air Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives medium cut quality and minimum dross levels



Imperial

Material Thickness		Preflow	Plasma	Shield	Postflow	Arc Voltage	Travel Speed	Cutting Height	Pierce Height	Pierce Time	Kerf Width
(ga)	(in)	(psi)	(psi)	(psi)	(psi)	(volts)	(ipm)	(in)	(in)	(msec)	(in)
10	.135	25	80	25	79	132	120	.060	.150	200	.085
	3/16					134	100	.070	.200	300	
	1/4					140	75	.090	.225	400	.090
	3/8					148	50	.120	.250	500	

Metric

Material Thickness	Preflow	Plasma	Shield	Postflow	Arc Voltage	Travel Speed	Cutting Height	Pierce Height	Pierce Time	Kerf Width
(mm)	(psi)	(psi)	(psi)	(psi)	(volts)	(mm/m)	(mm)	(mm)	(msec)	(mm)
3	25	80	25	79	131	3210	1.4	3.3	200	2.2
5					134	2445	1.8	5.1	400	
6					138	2050	2.1	5.5		2.3

Marking

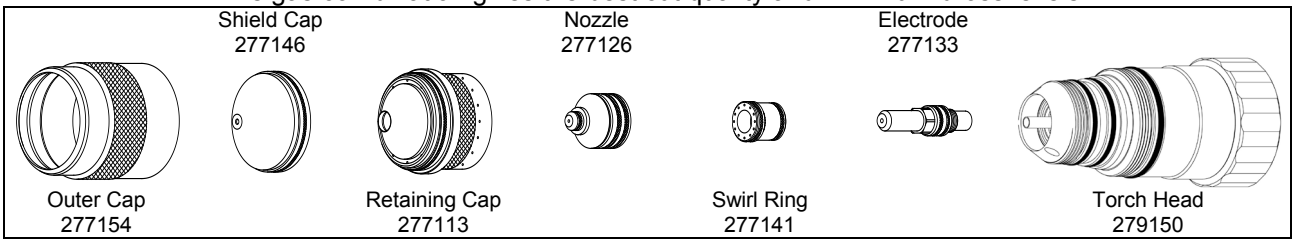
Material Thickness			Preflow	Plasma	Shield	Postflow	Arc Voltage	Travel Speed		Marking Height		Initial Height		Pierce Time
(ga)	(in)	(mm)	(psi)	(psi)	(psi)	(psi)	(volts)	(ipm)	(mm/min)	(in)	(mm)	(in)	(mm)	(msec)
All Thicknesses			N/A	28	25	N/A	135	250	6350	.096	2.4	.100	2.5	0

* Use an arc transfer height (ignition height) of .150" (3.8 mm) for cutting and .100" (2.5 mm) for marking
(Revised 10/22/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 100 Amps - H17 Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives the best cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
3/16	28	67	46	67	138	115	.105	.200	300	.100
1/4					140	100	.125	.225	400	.105
3/8					152	65	.180	.250	500	

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
5	28	67	46	67	138	2865	2.7	5.1	400	2.5
6					139	2625	3.0	5.5		2.7

Marking

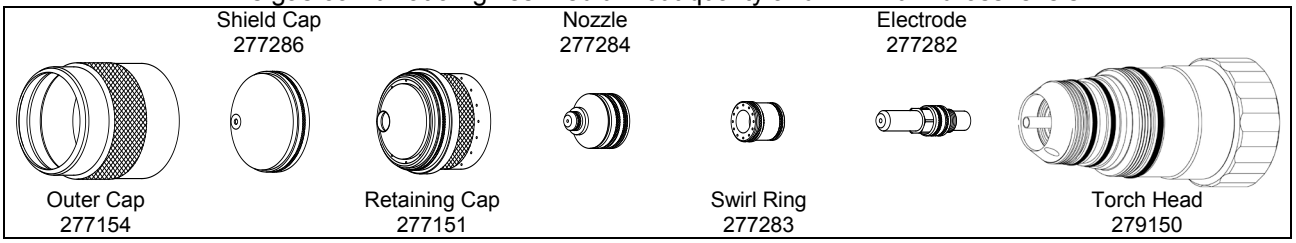
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	130	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
(Revised 12/1/09)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 100 Amps - Air Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives medium cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	25	94	35	93	141	100	.135	.225	400	.092
3/8					147	80	.170	.250	500	.095
1/2					154	55	.210	.300	600	

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	25	94	35	93	140	2595	3.2	5.6	400	2.3
10					148	1935	4.4	6.5	600	2.4
12					152	1540	5.0	7.3		

Marking

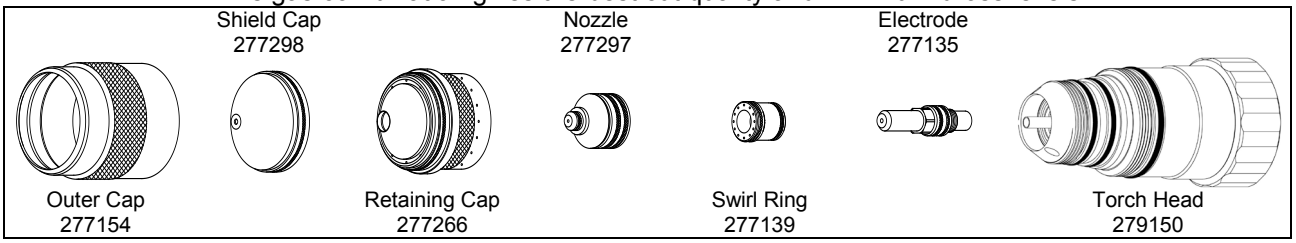
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	130	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
(Revised 10/21/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 150 Amps – H17 Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives the best cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	25	81	75	81	165	95	.250	.250	400	.135
3/8						75	.150	.275	500	
1/2						60	.165	.300	600	.140
5/8						50	.185	.325	800	
3/4						40	.250	.350	1200	.145

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
10	25	81	75	81	155	1845	3.8	7.0	600	3.4
12						1610	4.1	7.4		3.6
16						1260	4.7	8.3	800	
20					167	940	6.9	9.0	1200	3.7

Marking

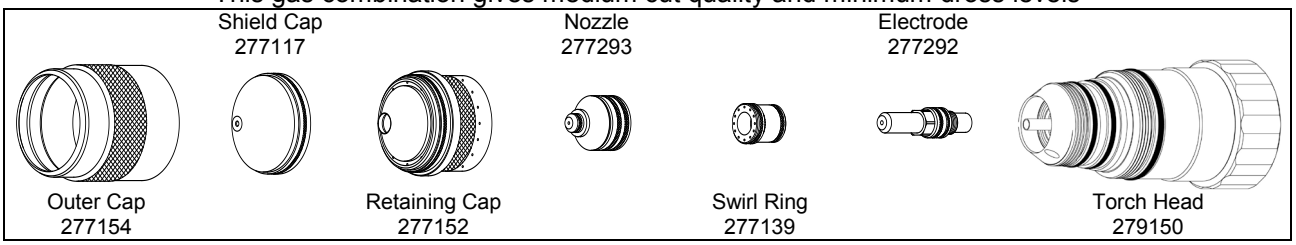
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	135	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
(Revised 12/01/09)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 150 Amps - Air Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives medium cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	25	75	70	67	145	150	.160	.250	400	.125
3/8					150	115	.180	.275	500	
1/2					155	85	.210	.300	600	.130
5/8					160	60	.220	.325	800	
3/4					168	45	.240	.350	1200	.135

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	25	75	70	67	144	3910	4.0	6.3	400	3.2
10					150	2805	4.7	7.0	600	
12					153	2330	5.1	7.4		3.3
16					160	1510	5.6	8.3	800	
20					170	1030	6.2	9.0	1200	3.4

Marking

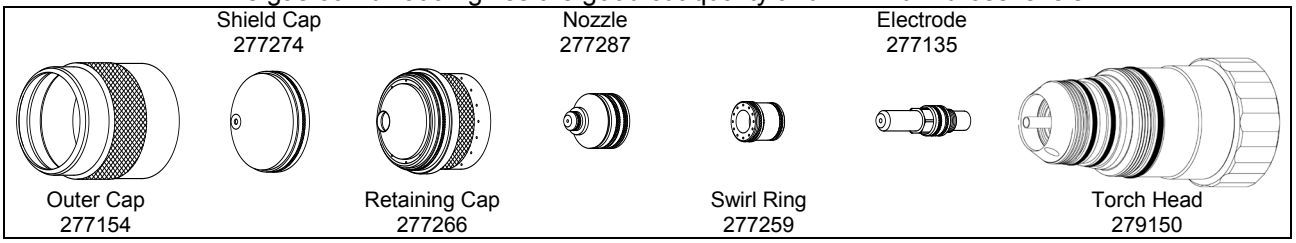
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	135	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
(Revised 12/01/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 200 Amps - H17 Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives the good cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
3/8	37	68	85	68	156	80	.195	.250	500	.150
1/2					148	75	.130	.300	600	
5/8					155	60	.190	.350	800	.155
3/4					160	50	.200	.400	1200	
1.0					170	35	.240	.450	1500	.160

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
10	37	68	85	68	154	2010	4.7	6.5	600	3.8
12					149	1935	3.6	7.3		
16					155	1515	4.8	8.9	800	3.9
20					161	1215	5.2	10.3	1500	
25					169	915	6.0	11.3		4.1

Marking

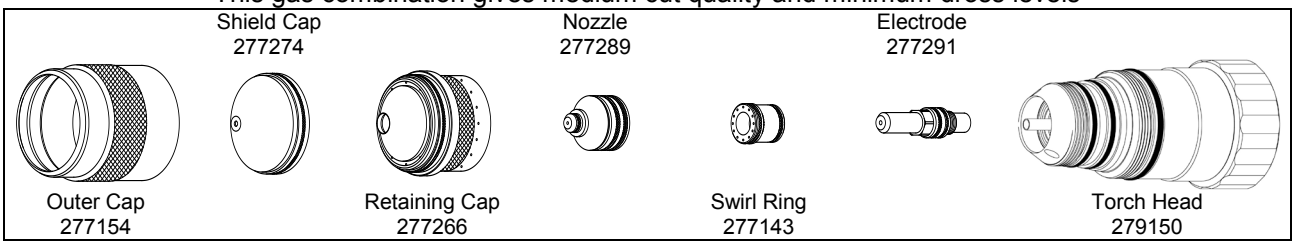
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	120	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
(Revised 12/01/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 200 Amps - Air Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives medium cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	20	82	58	75	130	200	.070	.200	400	.150
3/8					133	150		.250	500	
1/2					140	110	.115	.300	600	.152
5/8					146	75	.150	.350	800	.155
3/4					153	60	.190	.400	1200	
1.0					158	40	.210	.450	1500	.160
1.25 **					170	20	.250	.350		.165
1.50 **					180	10	.275	.350		.175

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	20	82	58	75	129	5220	1.8	4.9	400	3.8
10					134	3655	1.9	6.5	600	
12					138	3020	2.6	7.3		3.9
16					146	1890	3.8	8.9	800	
20					153	1450	4.8	10.3	1500	
25					157	1050	5.2	11.3		4.1
32 **					170	495	6.4	8.9		4.2
38 **					179	260	6.9	8.9		4.4

Marking

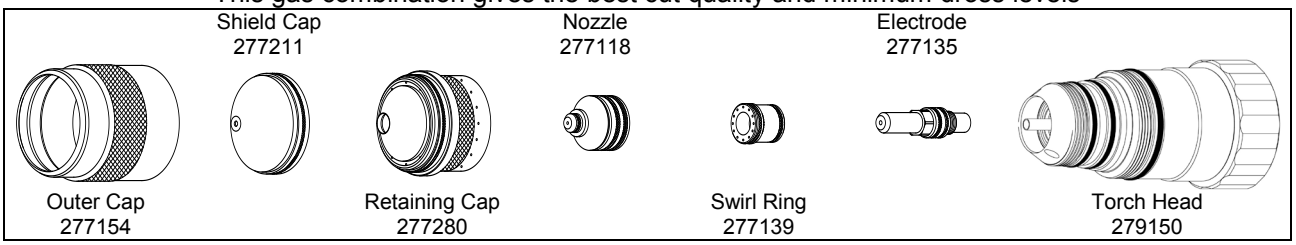
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	25	25	N/A	120	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised 12/01/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 260 Amps - H17 Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives the best cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
3/8	40	63	70	63	145	85	.160	.250	500	.190
1/2					142	80	.140	.300	600	
5/8					145	65	.185	.350	800	.195
3/4					150	55	.225	.400	1200	
1.0					160	33	.250	.450	1500	.200
1.25 **					170	26	.280	.350		.205

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
10	40	63	70	63	144	2140	4.0	6.5	600	4.8
12					142	2060	3.7	7.3		
16					145	1640	4.7	8.9	800	5.0
20					151	1315	5.8	10.3		
25					159	875	6.3	11.3	1500	5.1
32 **					170	650	7.1	8.7		5.2

Marking

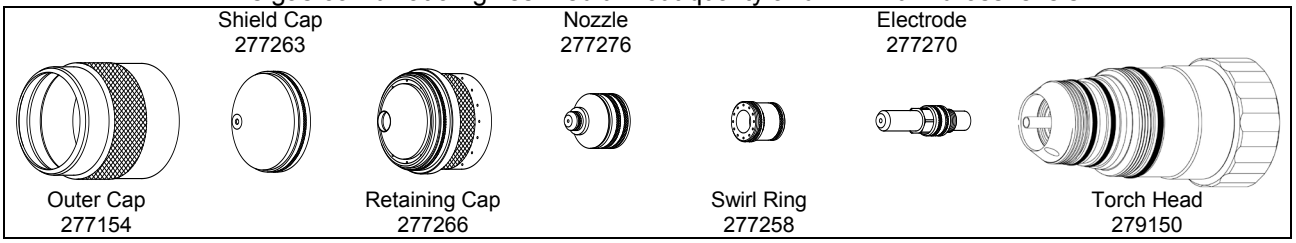
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	108	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .250" (6.4 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised 12/01 /2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 275 Amps - Air Plasma / Nitrogen Shield
Copper Electrode

This gas combination gives medium cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/2	20	93	70	83	143	120	.125	.300	600	.165
5/8					148	90	.140	.350	800	
3/4					152	80	.180	.400	1200	.170
1.0					165	55	.210	.450	1500	
1.25 **					175	35	.250	.350		.180
1.50 **					185	25	.300	.350		

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
12	20	93	70	83	141	3220	3.1	7.3	600	4.2
16					148	2275	3.6	8.9	800	
20					153	1940	4.7	10.3	1500	4.3
25					164	1435	5.2	11.3		
32 **					175	880	6.4	8.9		4.6
38 **					184	640	7.5	8.9		

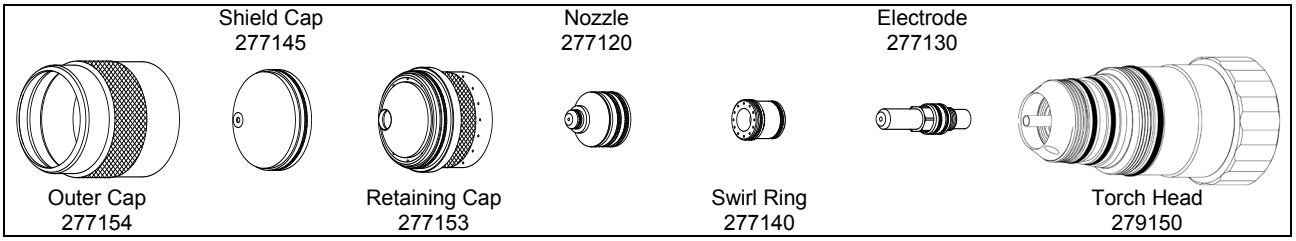
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	108	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .250" (6.4 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised 10/22/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Aluminum - 30 Amps - Air Plasma / Nitrogen Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
.040	30	92	20	90	135	150	.030	.100	100	.065
.050						120				
.063						90		.150	200	.070

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
1	30	92	20	90	135	3885	0.8	2.5	100	1.7
1.5						2520		3.4	200	1.8

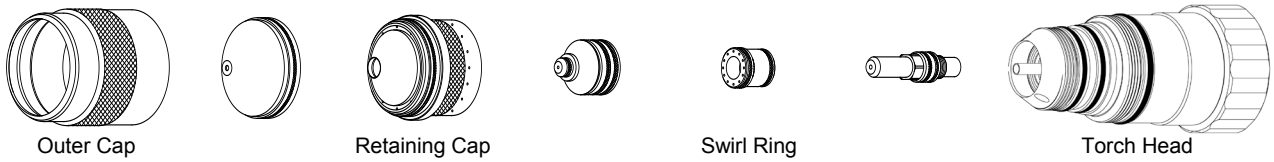
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	145	250	6350	.177	4.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .100" (2.5 mm) for cutting and .100" (2.5 mm) for marking
(Revised 12/01/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Aluminum - 50 Amps - Air Plasma / Nitrogen Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
.050	25	74	19	73	135	180	.050	.100	100	.080
.063					138	140	.065		150	.082
.080					143	90	.075	.150	200	.085

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
1.5	25	74	19	73	137	3870	1.5	2.5	150	2.1
2.0					142	2360	1.8	3.7	200	2.2

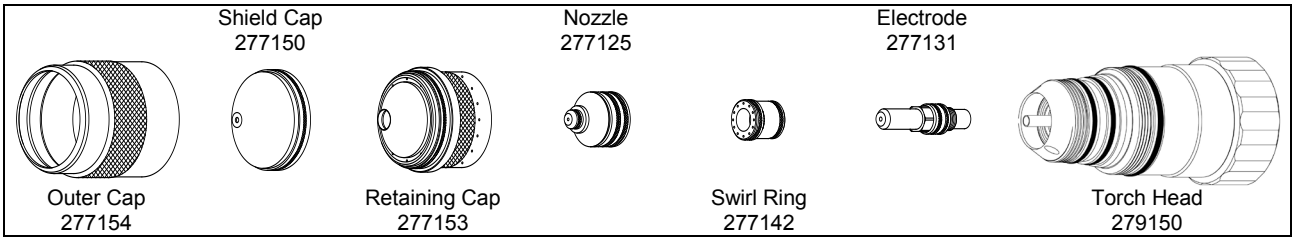
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	145	250	6350	.147	3.7	.100	2.5	0

* Use an arc transfer height (ignition height) of .100" (2.5 mm) for cutting and .100" (2.5 mm) for marking
(Revised 10/21/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Aluminum - 70 Amps - Air Plasma / Nitrogen Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
.080	25	80	25	79	130	250	.050	.150	100	.080
1/8					135	160	.070	.175		
3/16					145	80	.100	.200	200	.085
1/4					150	50	.060	.250	300	
3/8					155	40	.075	.275	400	.090
1/2					162	30	.115	.300	500	

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
2	25	80	25	79	129	6400	1.2	3.7	100	2.0
3					134	4420	1.7	4.3		
5					145	1920	2.3	5.2	300	2.2
6					148	1440	1.7	6.1		
10					156	975	2.0	7.0	500	2.3
12					160	820	2.6	7.4		

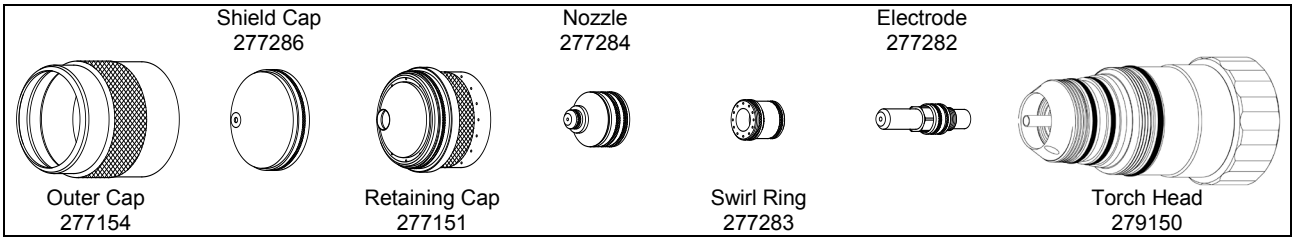
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	135	250	6350	.096	2.4	.100	2.5	0

* Use an arc transfer height (ignition height) of .150" (3.8 mm) for cutting and .100" (2.5 mm) for marking
(Revised 10/22/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Aluminum - 100 Amps - Air Plasma / Nitrogen Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	25	94	26	93	158	105	.155	.250	300	.095
3/8					162	90	.180	.275	400	.098
1/2					165	70	.195	.300	500	.100

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	25	94	26	93	158	2710	3.8	6.3	300	2.4
10					162	2210	4.6	7.0	500	2.5
12					165	1890	4.9	7.4		

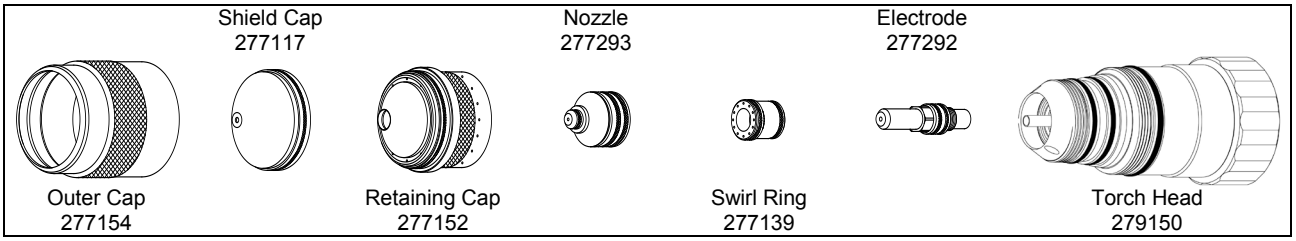
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	130	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .250" (6.4 mm) for cutting and .100" (2.5 mm) for marking
(Revised 02/23/2010)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Aluminum - 150 Amps - Air Plasma / Nitrogen Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	25	75	50	67	145	145	.130	.250	400	.125
3/8					155	115	.185	.275	500	
1/2					165	90	.230	.300	600	.130
5/8					170	65	.250	.325	800	.135
3/4						45		.350	1200	.140

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	25	75	50	67	143	3770	3.1	6.3	400	3.2
10					156	2825	4.8	7.0	600	
12					162	2430	5.5	7.4		3.3
16					170	1630	6.4	8.3	1200	3.4
20					170	990		9.0		3.6

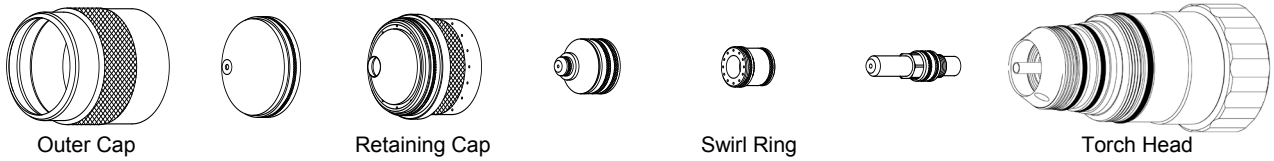
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	135	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .250" (6.4 mm) for cutting and .100" (2.5 mm) for marking
(Revised 12/01/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Aluminum - 200 Amps - Air Plasma / Nitrogen Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	20	82	58	75	150	190	.135	.250	300	.150
3/8					155	145	.140	.275	400	
1/2						110	.135	.300	500	.155
5/8					160	95		.350	600	
3/4						65	.150	.400	800	.160
1.0 **					175	35	.200		1000	.170

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	20	82	58	75	149	4955	3.3	6.3	300	3.8
10					155	3545	3.5	7.0	500	
12						2995	3.4	7.4		3.9
16					160	2380		8.9	800	
20					162	1575	3.9	10.2	1000	4.1
25 **					174	940	5.0			4.3

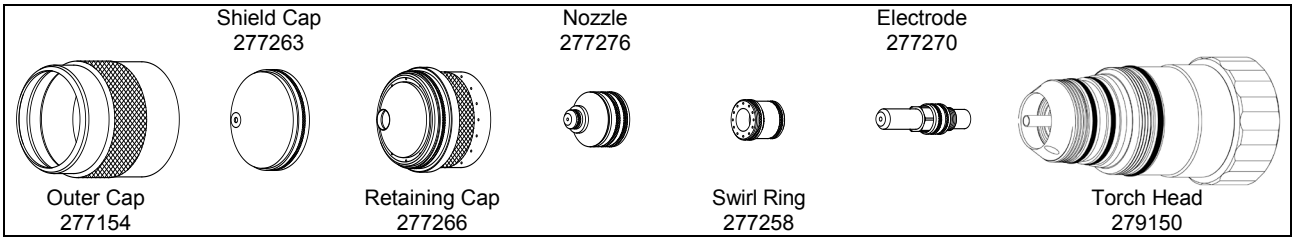
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	120	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .250" (6.4 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised 10/21/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Aluminum - 275 Amps - Air Plasma / Nitrogen Shield
Copper Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
3/8	20	93	65	83	160	160	.160	.275	400	.160
1/2					165	125	.180	.300	500	
5/8					168	105	.190	.350	600	.165
3/4					172	85	.200	.400	800	
1.00 **					180	60	.240		1000	.170
1.25 **					185	45	.260			
1.50 **					190	25	.270			.180

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
10	20	93	65	83	160	3930	4.1	7.1	500	4.1
12					163	3375	4.4	7.4		
16					168	2645	4.8	8.9	800	4.2
20					173	2055	5.3	10.2		
25 **					179	1565	6.0		1000	4.3
32 **					185	1120	6.6			
38 **					189	645	6.8			4.6

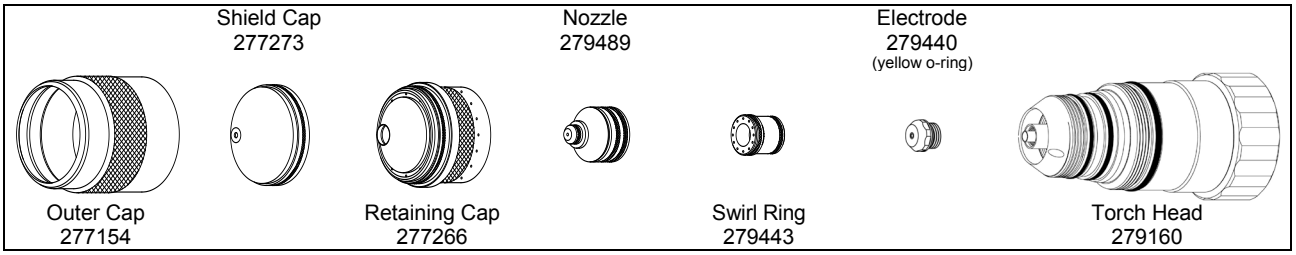
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	108	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .275" (7.0 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised10/22/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Mild Steel - 200 Amps – Oxygen Plasma / Air Shield
Silver Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	20	82	58	75	125	230	.040	.200	300	.150
3/8					130	140	.090	.250	400	
1/2					133	120	.115	.300	500	
5/8					137	100	.130	.350	600	.152
3/4					140	75	.150	.400	800	.153
1					147	50	.175	.450	1000	.155
1.25					155	25	.240	.500	1500	
1.5 **					165	17	.300	.350		158
1.75 **					175	12	.350			
2.0 **					185	7	.500	.500		.160

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	20	82	58	75	124	6100	.8	4.9	300	3.8
10					130	3480	2.3	6.5	500	
12					132	3160	2.7	7.3		
16					137	2515	3.3	8.9	800	3.9
20					141	1810	3.8	10.3	1000	
25					146	1310	4.3	11.3		
32					155	610	6.1	12.7	1500	
38 **					164	435	7.5	8.9		4.0
45 **					175	295	9.2	9.2		
50 **					183	195	12.2	12.2		4.1

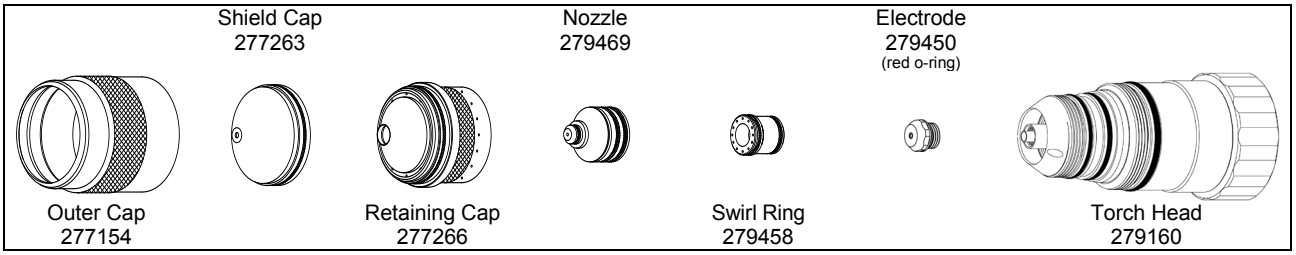
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	120	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised 12/01/09

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Mild Steel - 275 Amps - Oxygen Plasma / Air Shield
Silver Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/2	20	93	70	83	139	125	.140	.300	500	.165
5/8						105	.135	.325	600	
3/4					138	90	.120	.350	800	.170
1					144	65	.160	.400	1000	.185
1.25					150	45	.175	.500	1500	
1.50 **					163	25	.235	.350		.190
1.75 **					170	20	.290			
2.00 **					180	15	.350			
2.25 **					185	13	.375	.375		.260
2.50 **					190	9	.385	.385		.275

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
12	20	93	70	83	139	3290	3.6	7.4	500	4.2
16					138	2650	3.3	8.3	800	
20						2190	3.1	9.0	1000	4.3
25					143	1690	4.0	10.1		4.7
32					150	1120	4.4	12.8	1500	
38 **					162	645	5.9	8.9		4.8
45 **					170	495	7.5			
50 **					178	395	8.7			
55 **					183	345	9.2	9.2		6.6
60 **					187	285	9.6	9.6		6.9

Marking

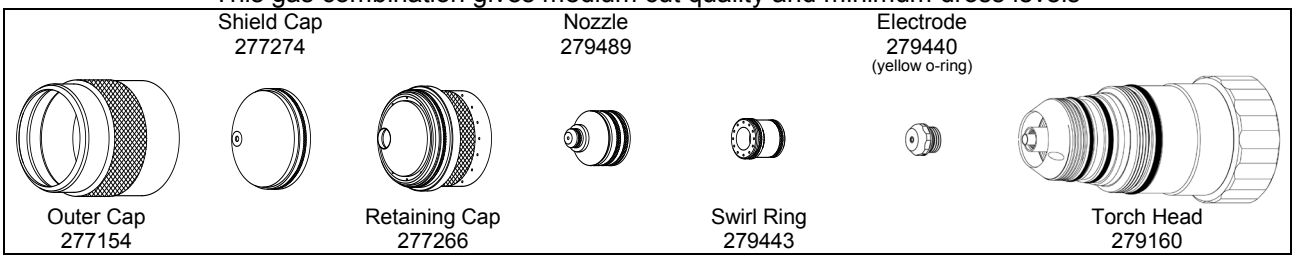
Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	28	N/A	108	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .300" (7.6 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended.
(Revised 10/22/09)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Stainless Steel - 200 Amps - Air Plasma / Nitrogen Shield
Silver Electrode

This gas combination gives medium cut quality and minimum dross levels



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	20	82	58	75	130	200	.070	.200	400	.150
3/8					133	150		.250	500	
1/2					140	110	.115	.300	600	.152
5/8					146	75	.150	.350	800	.155
3/4					153	60	.190	.400	1200	
1.0					158	40	.210	.450	1500	.160
1.25 **					170	20	.250	.350		.165
1.50 **					180	10	.275	.350		.175

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	20	82	58	75	129	5220	1.8	4.9	400	3.8
10					134	3655	1.9	6.5	600	
12					138	3020	2.6	7.3		3.9
16					146	1890	3.8	8.9	800	
20					153	1450	4.8	10.3	1500	
25					157	1050	5.2	11.3		4.1
32 **					170	495	6.4	8.9		4.2
38 **					179	260	6.9	8.9		4.4

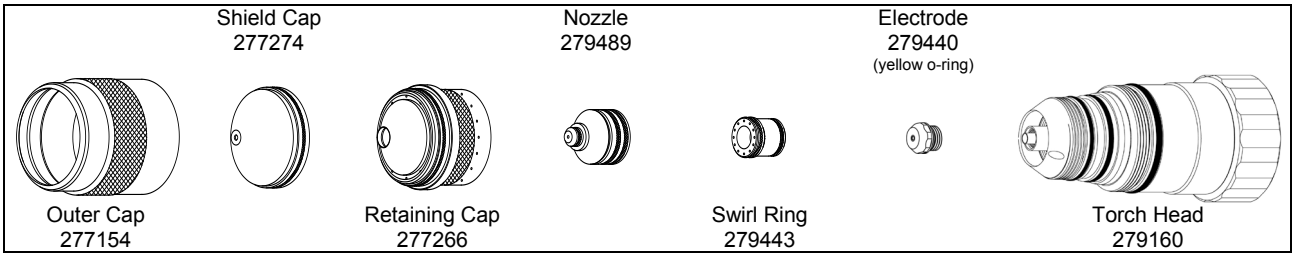
Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	25	25	N/A	120	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .200" (5.1 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised 12/01/2009)

This information is subject to the controls of the Export Administration Regulations [EAR]. This information shall not be provided to non-U.S. persons or transferred by any means to any location outside the United States contrary to the requirements of the EAR.

Aluminum - 200 Amps - Air Plasma / Nitrogen Shield
Silver Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
1/4	20	82	58	75	150	190	.135	.250	300	.150
3/8					155	145	.140	.275	400	
1/2						110	.135	.300	500	.155
5/8					160	95		.350	600	
3/4						65	.150	.400	800	.160
1.0 **					175	35	.200		1000	.170

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
6	20	82	58	75	149	4955	3.3	6.3	300	3.8
10					155	3545	3.5	7.0	500	
12						2995	3.4	7.4		3.9
16					160	2380		8.9	800	
20					162	1575	3.9	10.2	1000	4.1
25 **					174	940	5.0			4.3

Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	120	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .250" (6.4 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised 10/21/2009)

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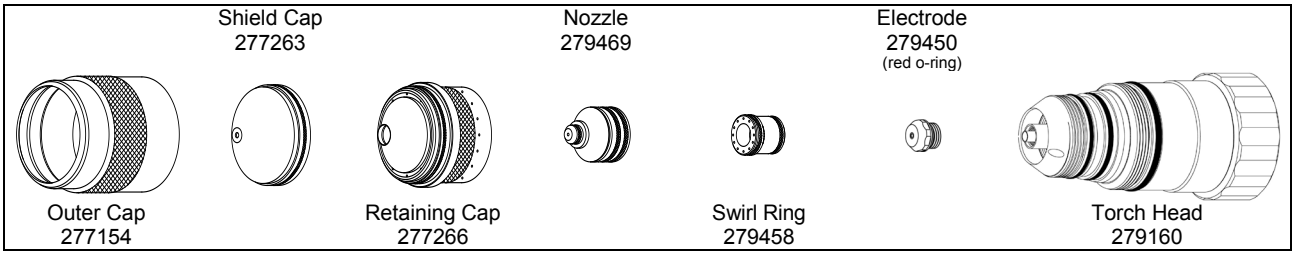
Aluminum - 275 Amps - Air Plasma / Nitrogen Shield
Silver Electrode



Imperial

Material Thickness (in)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	Cutting Height (in)	Pierce Height (in)	Pierce Time (msec)	Kerf Width (in)
3/8	20	93	65	83	160	160	.160	.275	400	.160
1/2					165	125	.180	.300	500	
5/8					168	105	.190	.350	600	.165
3/4					172	85	.200	.400	800	
1.00 **					180	60	.240		1000	.170
1.25 **					185	45	.260			
1.50 **					190	25	.270			.180

Metric

Material Thickness (mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (mm/m)	Cutting Height (mm)	Pierce Height (mm)	Pierce Time (msec)	Kerf Width (mm)
10	20	93	65	83	160	3930	4.1	7.1	500	4.1
12					163	3375	4.4	7.4		
16					168	2645	4.8	8.9	800	4.2
20					173	2055	5.3	10.2		
25 **					179	1565	6.0		1000	4.3
32 **					185	1120	6.6			
38 **					189	645	6.8			4.6

Marking

Material Thickness (ga)	(in)	(mm)	Preflow (psi)	Plasma (psi)	Shield (psi)	Postflow (psi)	Arc Voltage (volts)	Travel Speed (ipm)	(mm/min)	Marking Height (in)	(mm)	Initial Height (in)	(mm)	Pierce Time (msec)
All Thicknesses			N/A	28	25	N/A	108	250	6350	.100	2.5	.100	2.5	0

* Use an arc transfer height (ignition height) of .275" (7.0 mm) for cutting and .100" (2.5 mm) for marking
** Edge start recommended
(Revised10/22/2009)

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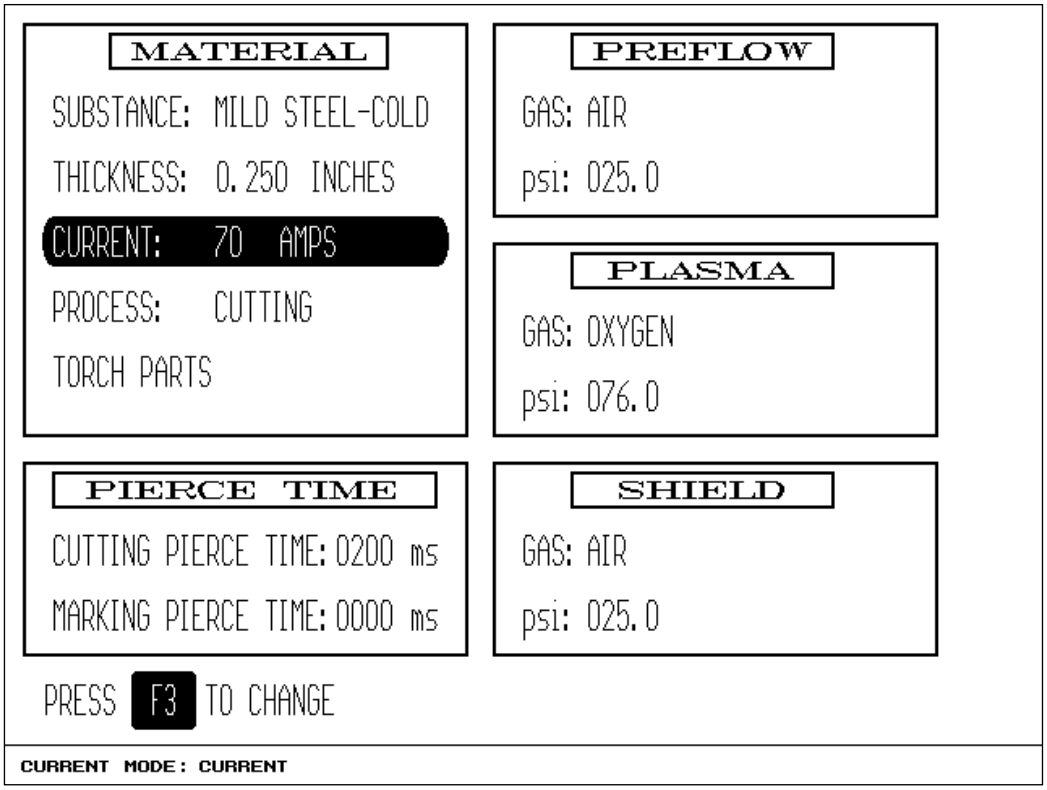
Section 5 Automatic Gas Console Advanced Functions

This section describes how to operate the Spirit system when non-standard cutting or marking conditions are desired. Instructions are also given on how to access the various maintenance modes of the system.

Altering the Current Set Point

To alter the current set point from the default setting, use the arrow keys to scroll to Current Set Point, or press the Menu key then the Current key. The current setting should be highlighted as shown and the set point should be blinking. Press F3 to scroll through the available current choices. The current can only be set to values of 30, 50, 70, 100, 150, 200, 260, or 275 amps when cutting. When marking, the current cannot be changed. Once the desired value is blinking, press ENT.



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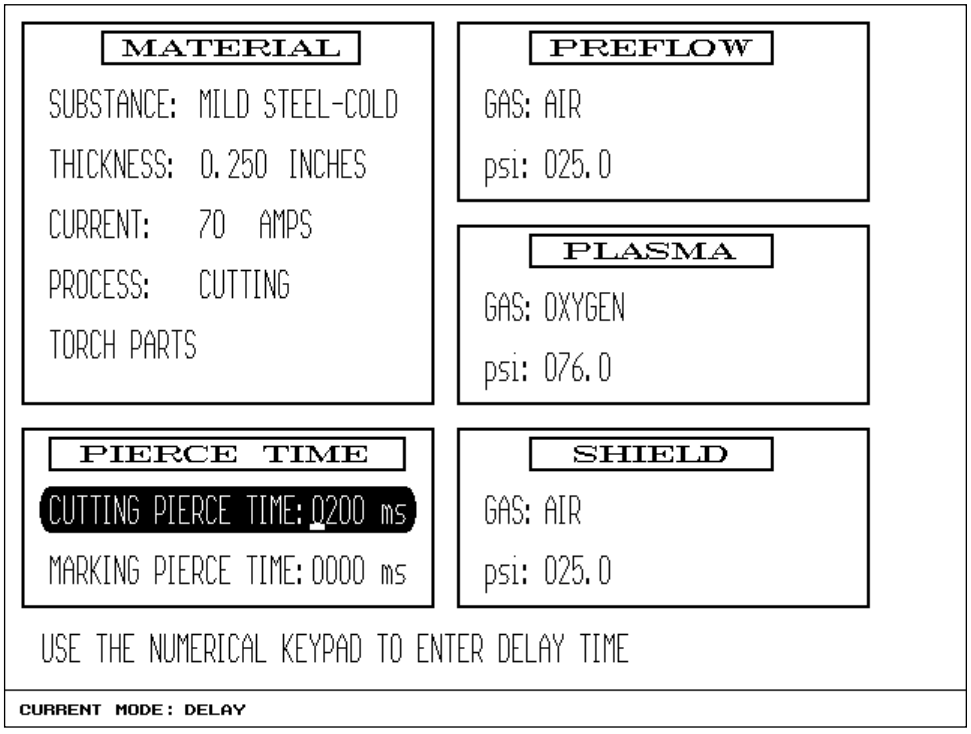
Setting the Pierce Time

After the Spirit cutting or marking arc transfers to the workpiece, a motion signal (ok to move signal) is sent to the x/y controller or torch height control. When the motion signal is issued, the x/y controller or torch height control should position the torch to the correct pierce height. The torch should remain at the pierce height until the Pierce Time has elapsed, at which time the torch should be positioned at the correct cutting or marking height. When cutting, the Pierce Time should be adjusted so the arc fully penetrates the plate before the torch is moved to the cut height. See "Piercing Thick Materials" in Section 4. When marking, the Pierce Time is usually adjusted to zero. To alter the Pierce Time, use the arrow keys to scroll to Cutting Pierce Time or Marking Pierce Time. The pierce time should be highlighted as shown and the editing cursor should be blinking. Use the numerical keypad to enter the desired Pierce Time. Note that the units are in milliseconds (1000 milliseconds = 1 second). Use the CLR key to backspace if an error is made. When the correct value has been entered, press ENT. Note that the maximum allowable Pierce Time is 5000 milliseconds (5 seconds).



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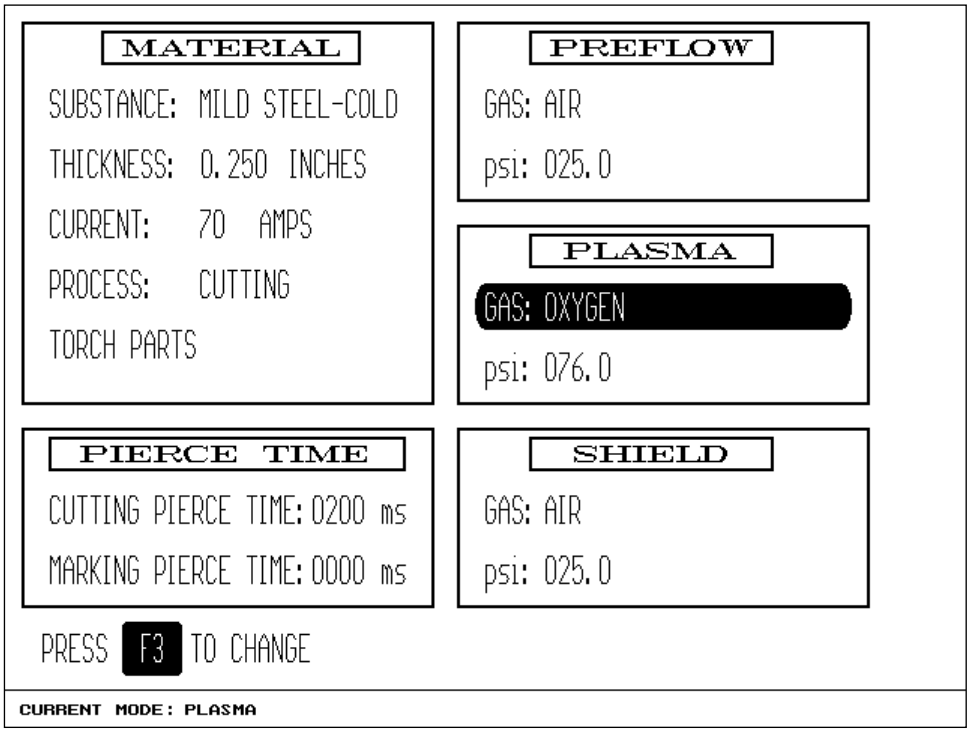
Altering Gas Types

Although the gas types should not normally be changed, the procedure is given here anyway. Note that the preflow gas cannot be changed. To alter the gas types used for a particular cut, use the arrows to scroll to the appropriate gas or press the Menu key then the Plasma Gas or Shielding Gas key. The appropriate gas selection should be highlighted as shown and the present gas choice should be blinking. Press F3 to scroll through the gas choices. When the desired gas type is blinking, press ENT to accept the gas type. The plasma gas can be changed to air, oxygen, or H17 and the shield gas can be changed to air, oxygen, or nitrogen.



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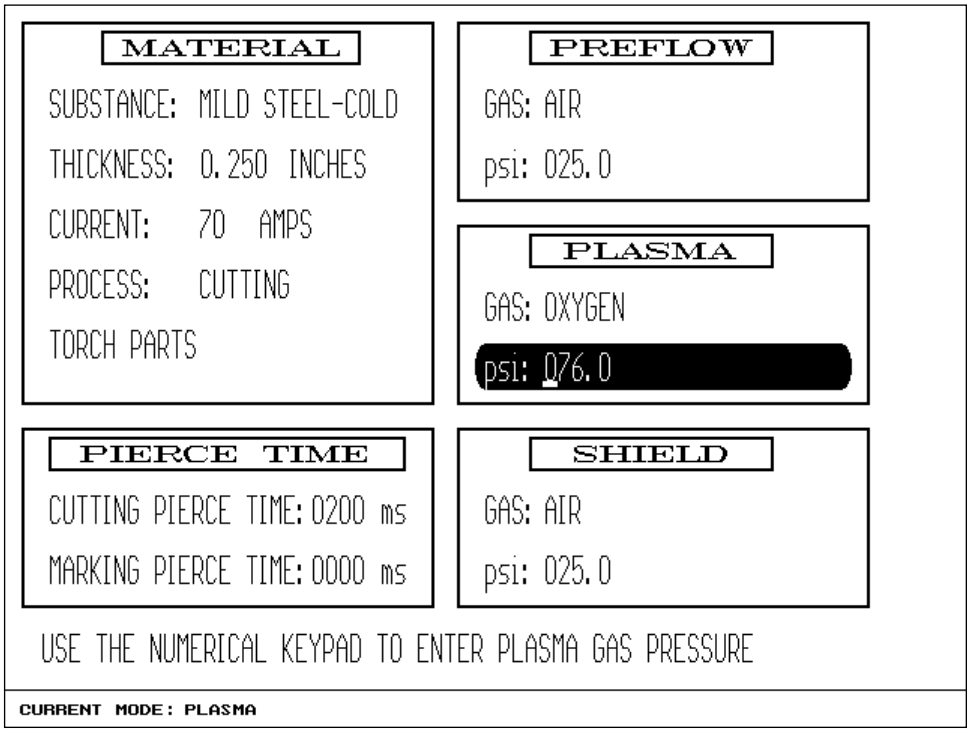
Altering Gas Pressures

Normally, the preflow gas and plasma gas pressures should not be changed. The shield gas can be adjusted in small increments to fine-tune a cut. To alter the gas pressures, use the arrow keys to scroll to the appropriate pressure setting. The pressure setting should be highlighted as shown and the editing cursor should be blinking. Use the numerical keypad to enter the desired operating pressure. Use the CLR key to backspace if an error is made. Press ENT when the correct value has been entered. Note that all of the gases have minimum and maximum limits and cannot be programmed beyond these limits.



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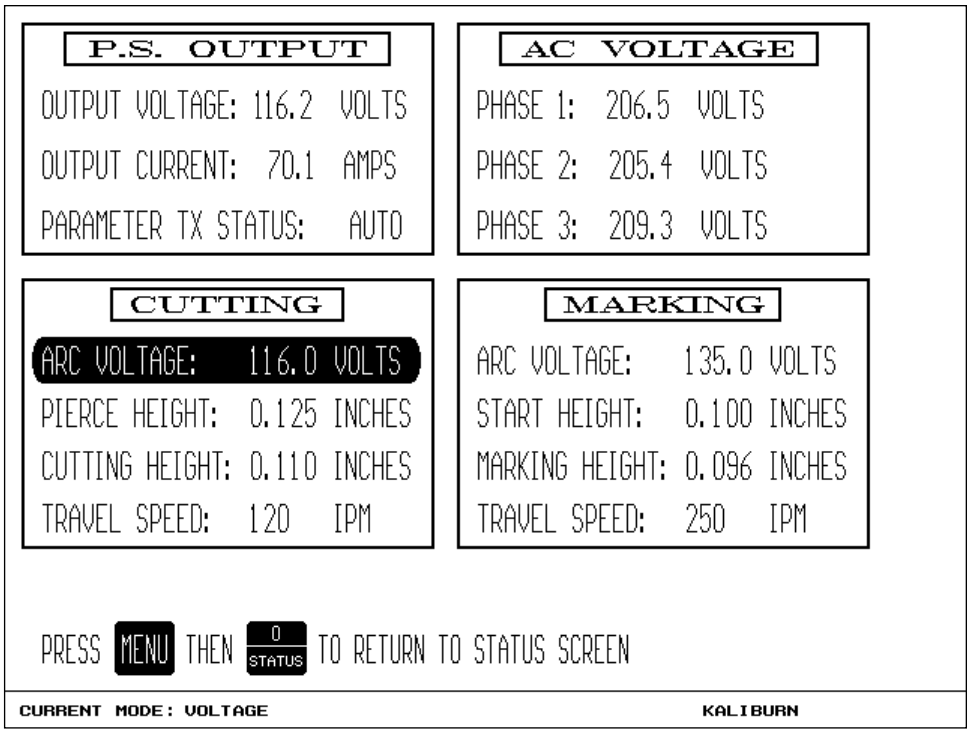
Altering Arc Voltage Control and X/Y Machine Parameters

If the pierce (initial) height, cutting (marking) height, arc voltage, or x/y machine speed must be altered to achieve the desired cut quality, switch to the voltage screen, use the arrow keys to scroll to the desired parameter, and edit the parameter using the keypad.



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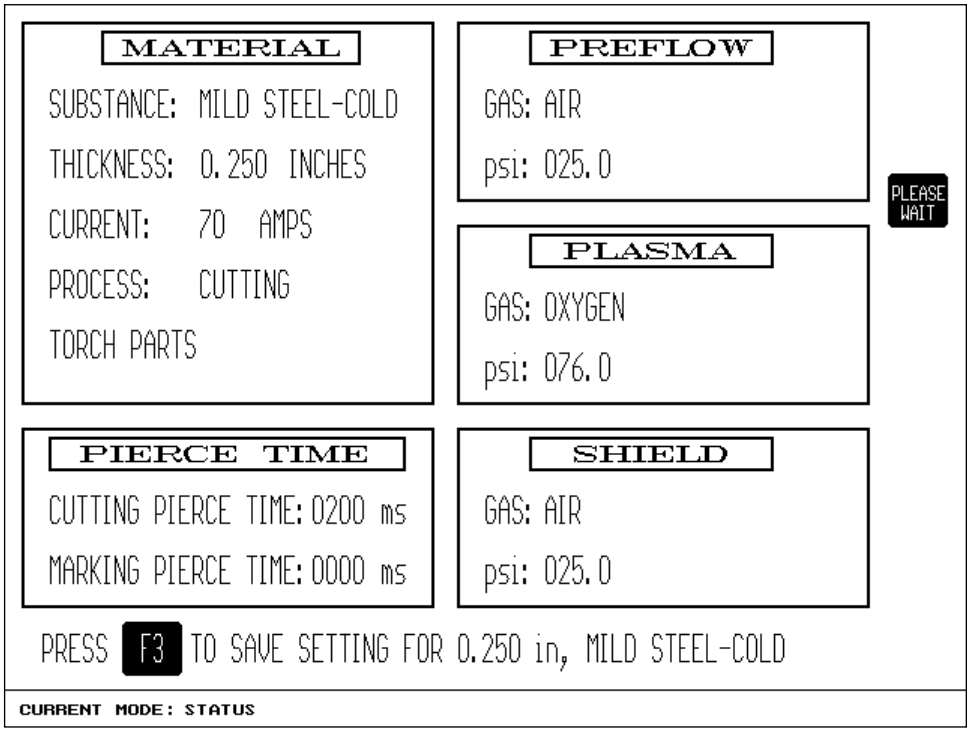
Saving a User Created Cutting or Marking Condition

If one of the default cutting or marking parameters must be altered to achieve the desired quality, the new condition can be saved for later use. To save a user created cutting or marking condition, use the arrow keys to scroll off all selections on the status screen. When none of the parameters are highlighted the "Press F3 to Save Settings" message will be displayed as shown. Pressing F3 will cause the save confirmation window to pop up. When this occurs, press ENT to save the condition or press CLR to cancel the procedure. Pressing ENT will save the settings for the particular material being cut and a User icon will appear in the upper right hand corner of the screen. The User icon indicates that the parameters for the particular material being cut are not factory defaults but are user created. The factory default condition can be restored as described later in this section.



Gas Purge

The gas lines can be purged at any time by pressing the Menu key then the Gas Purge key. The gas pressures are also readjusted at this time.

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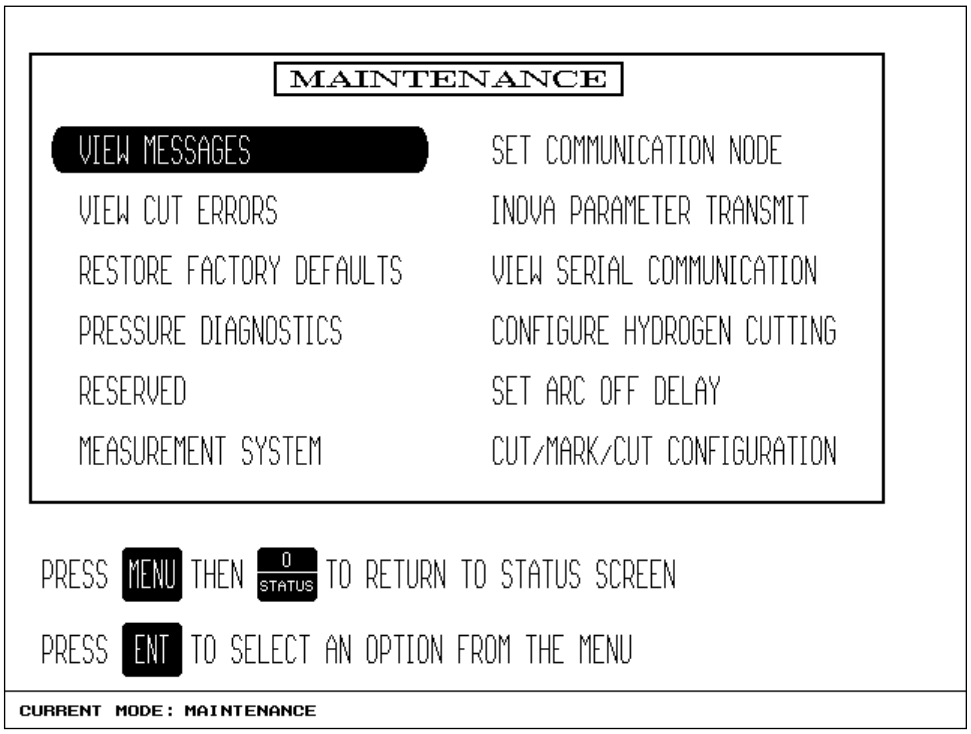
Maintenance Screen

To display the maintenance screen, press the Menu key then the Maint key. The maintenance screen will be displayed as shown. From the maintenance screen, use the arrow keys to scroll up or down to highlight a selection and press the Ent key to enter the desired maintenance mode. The different maintenance modes are described below.



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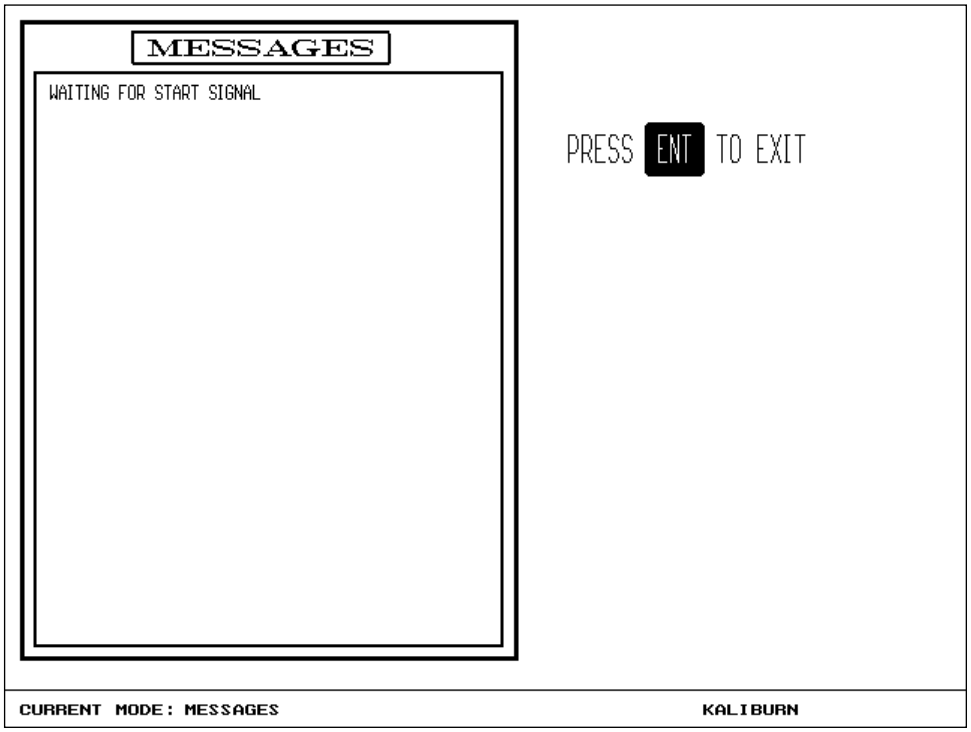
Viewing Messages

To view status messages from the Spirit power supply and automatic gas console, scroll down to the View Messages selection on the maintenance screen and press ENT. The message screen will be displayed as shown. The message screen displays all power supply and gas console messages, sequencing, and errors. The message screen should be the initial starting point when troubleshooting the system.



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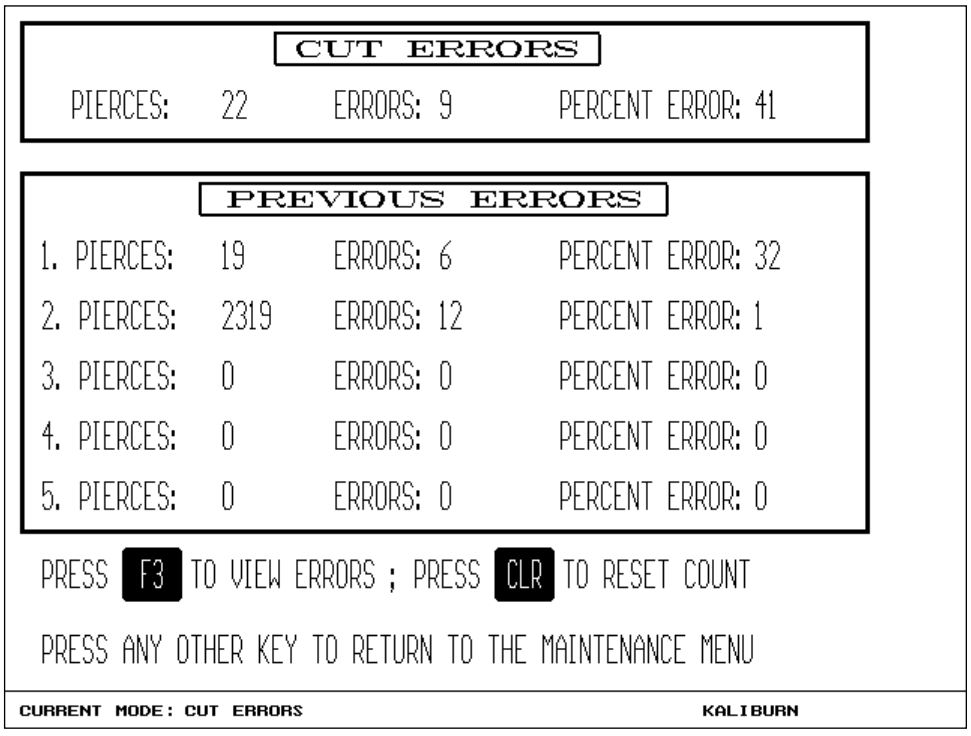
Viewing Cut Errors

The Spirit has an error tracking system that keeps a record of certain faults that occur during operation. These faults affect the consumable parts life and measures should be taken to prevent them from occurring. To view the cut errors, scroll down to the View Cut Errors selection on the maintenance screen and press ENT. The cut errors screen will be displayed as shown. The error tracking system keeps a record of the total number of pierces, the number of errors, and the error percentage. Any time the consumables are changed, the pierce counter should be reset to zero by pressing CLR. When this occurs, the data from the present count will move into the first previous errors position. The data that was in the first previous errors position will move to the second previous errors position, and so on.


CUT ERRORS
PIERCES: 22 ERRORS: 9 PERCENT ERROR: 41
PREVIOUS ERRORS
1. PIERCES: 19 ERRORS: 6 PERCENT ERROR: 32
2. PIERCES: 2319 ERRORS: 12 PERCENT ERROR: 1
3. PIERCES: 0 ERRORS: 0 PERCENT ERROR: 0
4. PIERCES: 0 ERRORS: 0 PERCENT ERROR: 0
5. PIERCES: 0 ERRORS: 0 PERCENT ERROR: 0
PRESS F3 TO VIEW ERRORS ; PRESS CLR TO RESET COUNT
PRESS ANY OTHER KEY TO RETURN TO THE MAINTENANCE MENU
CURRENT MODE: CUT ERRORS
KALIBURN

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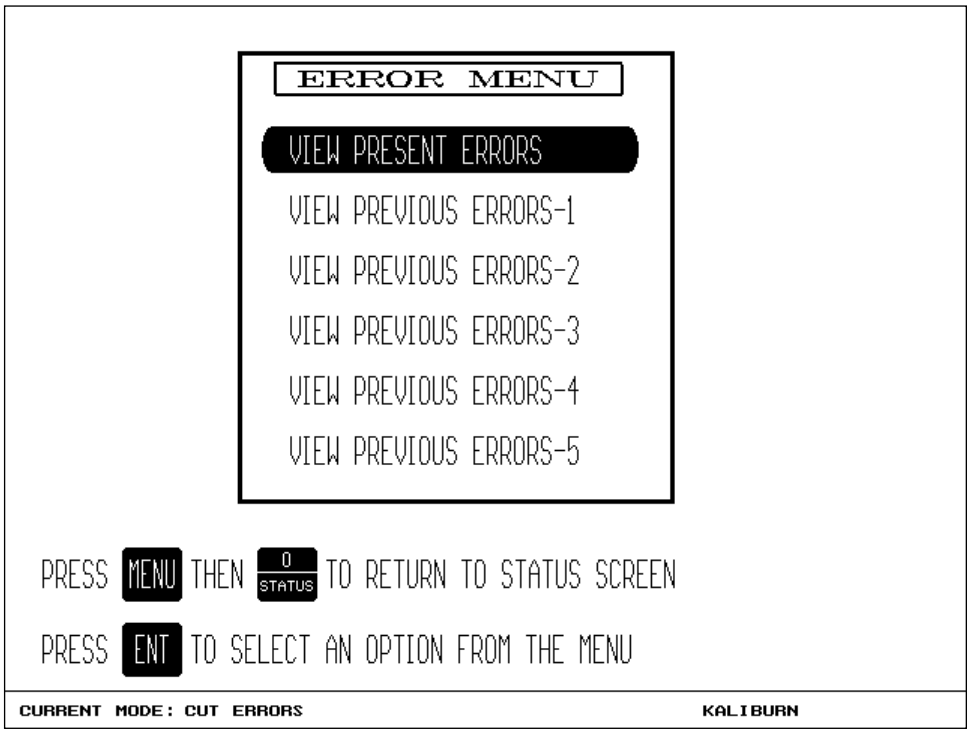
Selecting an Error Set to View

When the cut errors screen is being displayed, press F3 to view the actual cut errors. When F3 is pressed the error selection screen is displayed as shown. Use the arrow keys to scroll to the error set that is to be viewed and press ENT.


ERROR MENU
VIEW PRESENT ERRORS
VIEW PREVIOUS ERRORS-1
VIEW PREVIOUS ERRORS-2
VIEW PREVIOUS ERRORS-3
VIEW PREVIOUS ERRORS-4
VIEW PREVIOUS ERRORS-5
PRESS MENU THEN 0 STATUS TO RETURN TO STATUS SCREEN
PRESS ENT TO SELECT AN OPTION FROM THE MENU
CURRENT MODE: CUT ERRORS
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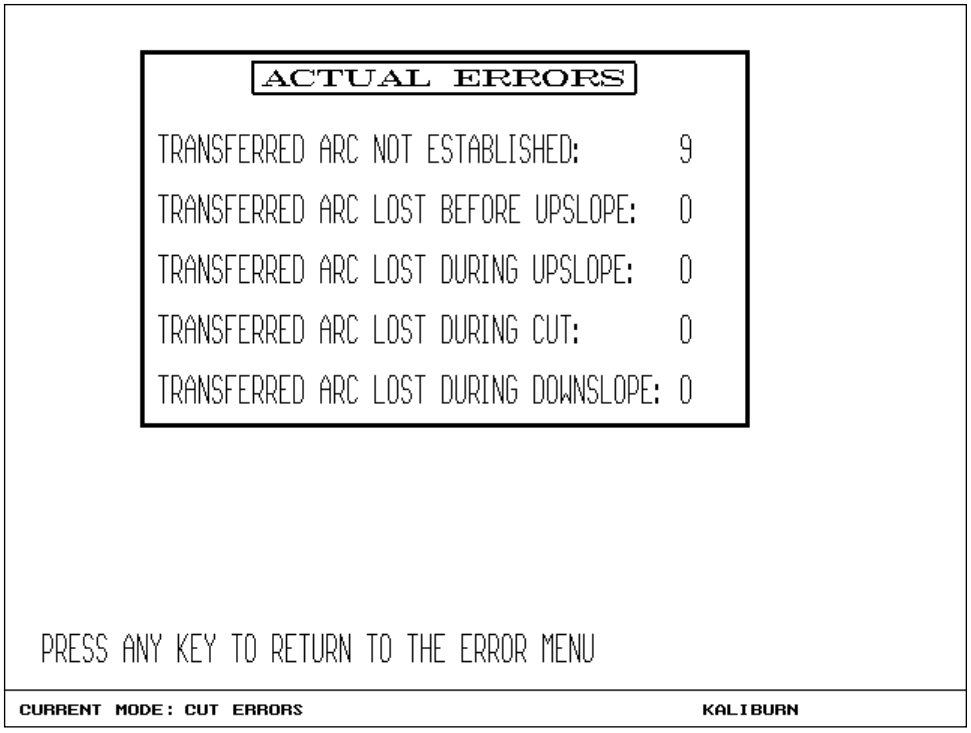
Viewing Actual Errors

Once the error set is selected and the ENT key is pressed on the error selection screen, the actual cut errors will be displayed as shown.


ACTUAL ERRORS
TRANSFERRED ARC NOT ESTABLISHED: 9
TRANSFERRED ARC LOST BEFORE UPSLOPE: 0
TRANSFERRED ARC LOST DURING UPSLOPE: 0
TRANSFERRED ARC LOST DURING CUT: 0
TRANSFERRED ARC LOST DURING DOWNSLOPE: 0
PRESS ANY KEY TO RETURN TO THE ERROR MENU
CURRENT MODE: CUT ERRORS
KALIBURN

When any of the errors listed on the actual cut errors screen occur, measures should be taken to avoid further errors. The following is a description of the errors and possible causes:

- **Transferred arc not established** - This error occurs when the arc fails to transfer to the workpiece. It primarily causes nozzle damage and is typically due to a pierce height that is too high.
- **Transferred arc lost before upslope** - This error occurs when the arc transfers to the workpiece but is lost immediately. It primarily causes nozzle damage and is typically due to a pierce height that is too high.
- **Transferred arc lost during upslope** - This error occurs when the arc transfers to the workpiece but is lost before steady state operation. It primarily causes electrode damage and is typically due to a pierce time that is too long or when cutting a given thickness with excessive current.
- **Transferred arc lost during cut** - This error occurs when the arc is lost during steady state operation. It substantially shortens the electrode life and is typically due to a torch standoff distance that is too high or a travel speed that is to slow.

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- **Transferred arc lost during downslope** - This error occurs when the arc is lost after a stop signal is received but before the current downslope completes. It substantially shortens the electrode life and is typically due to an incorrect lead-out or when cutting a given material thickness with excessive current. When cutting small pieces that tend to drop into the table after being cut, there should be a very short lead out or none at all. On thicker materials, the arc is sometimes lost when crossing the kerf during the lead out. **It is critical that the lead-outs be fine tuned so the arc is not lost before downslope is complete.**

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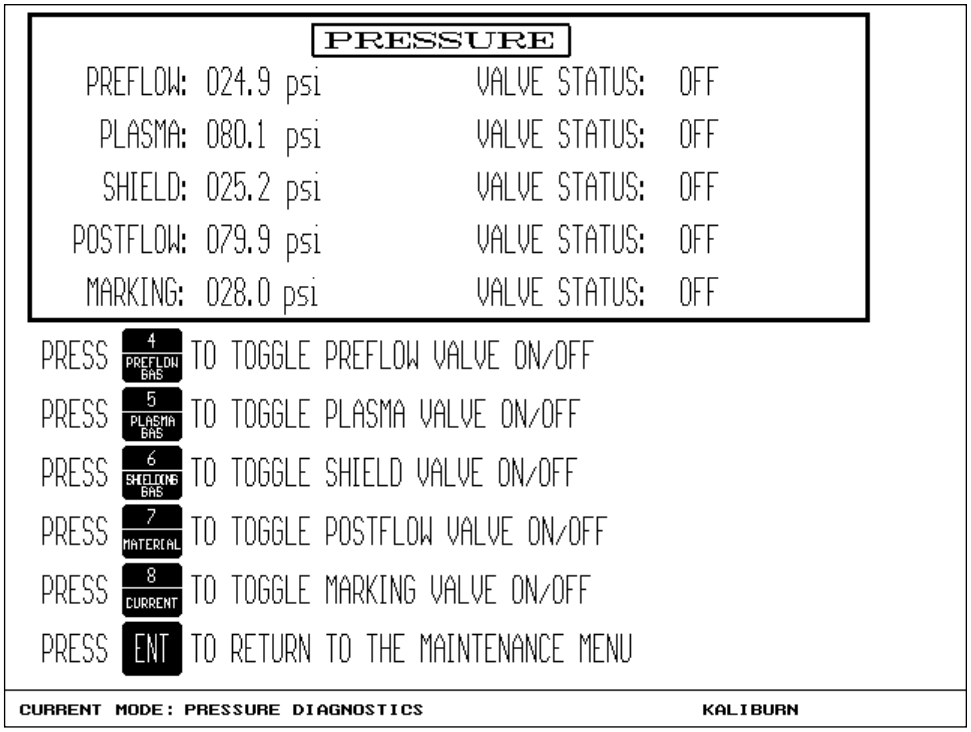
Pressure Diagnostics

To enter the pressure diagnostics mode, scroll down to the Pressure Diagnostics selection on the maintenance screen and press ENT. The pressure diagnostics screen will be displayed as shown. Pressing the Preflow Gas, Plasma Gas, and Shielding Gas buttons will toggle the corresponding valves between the off and on states. Note that the preflow valve and the plasma valve cannot be on at the same time. During a cutting or marking sequence, the status of all valves will display N/A.


PRESSURE
PREFLOW: 024.9 psi VALVE STATUS: OFF
PLASMA: 080.1 psi VALVE STATUS: OFF
SHIELD: 025.2 psi VALVE STATUS: OFF
POSTFLOW: 079.9 psi VALVE STATUS: OFF
MARKING: 028.0 psi VALVE STATUS: OFF
PRESS 4 PREFLOW GAS TO TOGGLE PREFLOW VALVE ON/OFF
PRESS 5 PLASMA GAS TO TOGGLE PLASMA VALVE ON/OFF
PRESS 6 SHIELDING GAS TO TOGGLE SHIELD VALVE ON/OFF
PRESS 7 MATERIAL TO TOGGLE POSTFLOW VALVE ON/OFF
PRESS 8 CURRENT TO TOGGLE MARKING VALVE ON/OFF
PRESS ENT TO RETURN TO THE MAINTENANCE MENU
CURRENT MODE: PRESSURE DIAGNOSTICS
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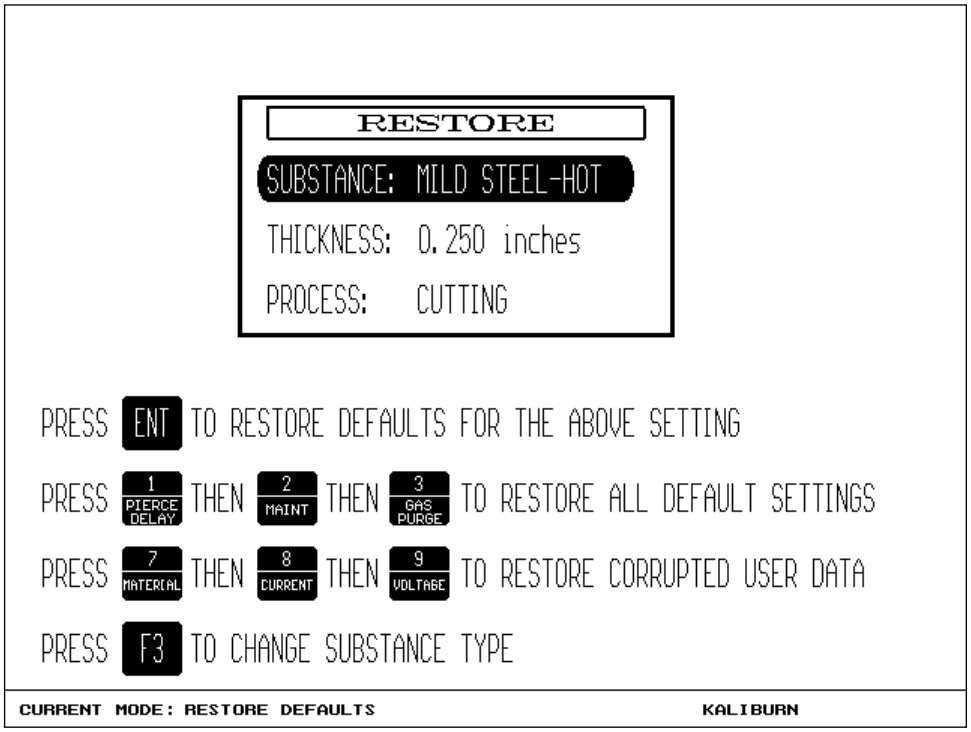
Restoring Factory Default Cutting or Marking Conditions

To restore a factory default cutting or marking condition, scroll down to the Restore Factory Defaults selection on the maintenance screen and press ENT. The restore screen will be displayed as shown. Note that the present material type and thickness selected on the status screen will be automatically displayed on the restore screen. Press ENT to restore the factory default setting for the material type and thickness displayed. To change the material type, press the F3 key. To edit the material thickness, use the arrow keys to scroll to Thickness and use the numerical keypad to enter the thickness. To restore the factory default cutting and marking conditions for all user saved files, press 1, then 2, then 3 as shown on the screen below. To restore corrupted cutting or marking conditions, press 7, then 8, then 9 as shown on the screen below.


RESTORE
SUBSTANCE: MILD STEEL-HOT
THICKNESS: 0.250 inches
PROCESS: CUTTING
PRESS ENT TO RESTORE DEFAULTS FOR THE ABOVE SETTING
PRESS 1 PIERCE DELAY THEN 2 MAINT THEN 3 GAS PURGE TO RESTORE ALL DEFAULT SETTINGS
PRESS 7 MATERIAL THEN 8 CURRENT THEN 9 VOLTAGE TO RESTORE CORRUPTED USER DATA
PRESS F3 TO CHANGE SUBSTANCE TYPE
CURRENT MODE: RESTORE DEFAULTS
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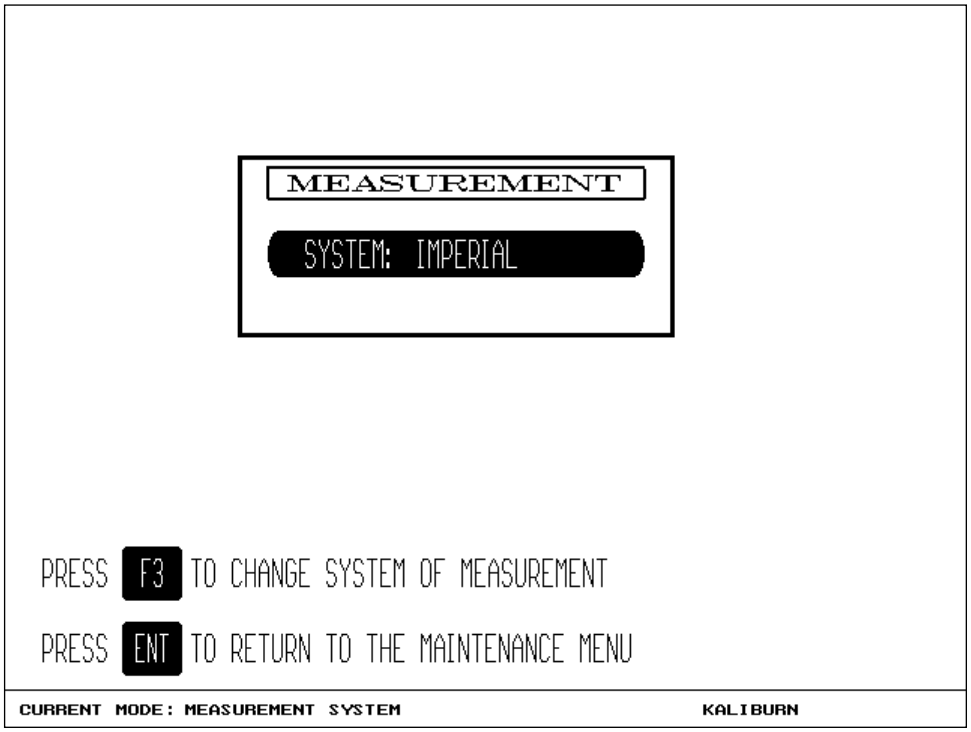
Measurement System

The Spirit system will operate using Imperial units or Metric units. To change the units of operation, scroll down to the Measurement System selection on the maintenance screen and press ENT. The measurement system screen will be displayed as shown. Press F3 to toggle the measurement system between Imperial and Metric. When the desired selection is highlighted, press ENT.



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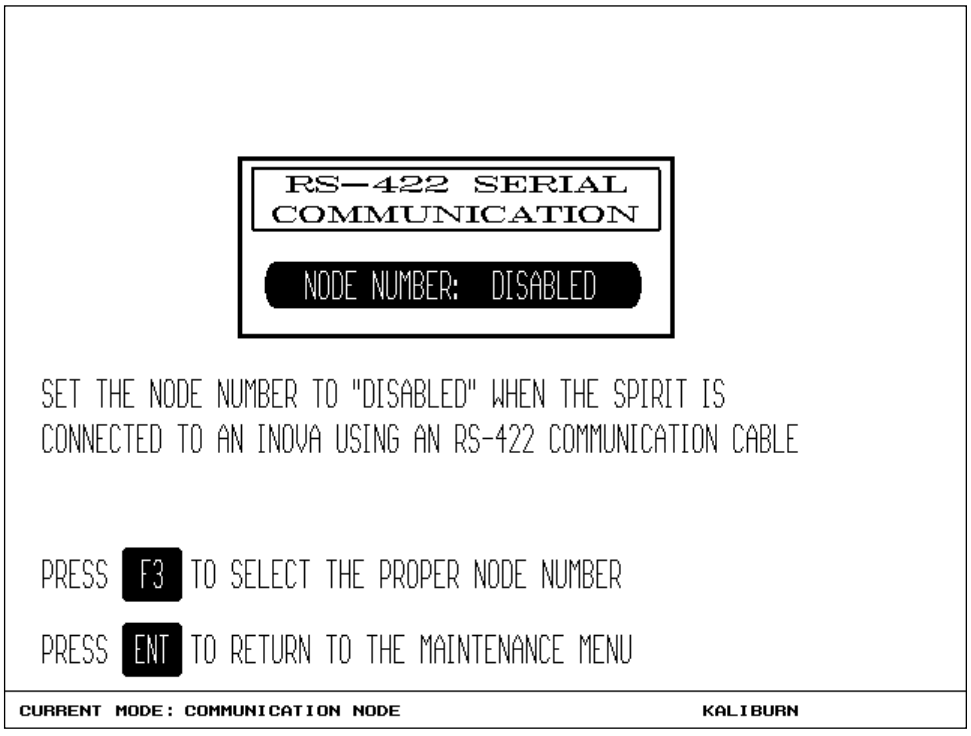
Communication Node

When multiple Spirit systems are being used together on an RS-422 serial communication link, each system must have a unique identification number (node number) to identify itself to the network. To set the communication node number for the Spirit system, scroll down to the Set Communication Node selection on the maintenance screen and press ENT. The communication node selection screen will be displayed as shown. Press F3 to scroll through the available node numbers. When using an Inova torch height control system with the Spirit, the communication node feature must be disabled. To disable the communication node, press F3 until "disabled" is displayed in the node number selection box. When the desired selection is highlighted, press ENT.


RS-422 SERIAL COMMUNICATION
NODE NUMBER: DISABLED
SET THE NODE NUMBER TO "DISABLED" WHEN THE SPIRIT IS CONNECTED TO AN INOVA USING AN RS-422 COMMUNICATION CABLE
PRESS F3 TO SELECT THE PROPER NODE NUMBER
PRESS ENT TO RETURN TO THE MAINTENANCE MENU
CURRENT MODE: COMMUNICATION NODE
KALIBURN

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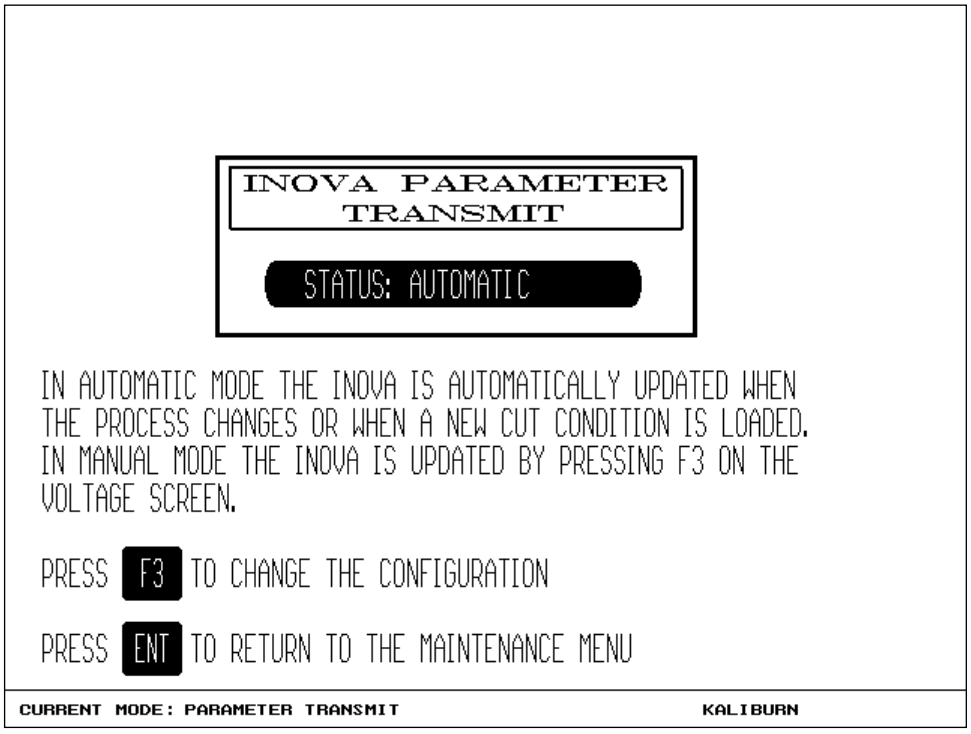
Inova Parameter Transmit

If an Inova arc voltage control system is not being used with the Spirit system, the Inova Parameter Transmit feature must be disabled. With the Inova Parameter Transmit feature set to automatic, the Inova is automatically updated with the correct arc voltage, pierce (initial) height, and cutting (marking) height any time a new condition is loaded, the process (cutting or marking) is changed, or when the arc voltage, pierce (initial) height, or cutting (marking) height is changed on the Voltage screen. With the Inova Parameter Transmit feature set to manual, pressing F3 while the voltage screen is being displayed will automatically transmit the pierce (initial) height, cutting (marking) height, and arc voltage set points to the Inova. To view the status of the Inova Parameter Transmit setting, scroll down to the Inova Parameter Transmit selection on the maintenance screen and press ENT. The Inova parameter transmit screen will be displayed as shown. Pressing F3 will toggle the Inova Parameter Transmit setting between automatic, manual, and disabled. When the desired selection is highlighted, press ENT.


INOVA PARAMETER TRANSMIT
STATUS: AUTOMATIC
IN AUTOMATIC MODE THE INOVA IS AUTOMATICALLY UPDATED WHEN THE PROCESS CHANGES OR WHEN A NEW CUT CONDITION IS LOADED. IN MANUAL MODE THE INOVA IS UPDATED BY PRESSING F3 ON THE VOLTAGE SCREEN.
PRESS F3 TO CHANGE THE CONFIGURATION
PRESS ENT TO RETURN TO THE MAINTENANCE MENU
CURRENT MODE: PARAMETER TRANSMIT
KALIBURN

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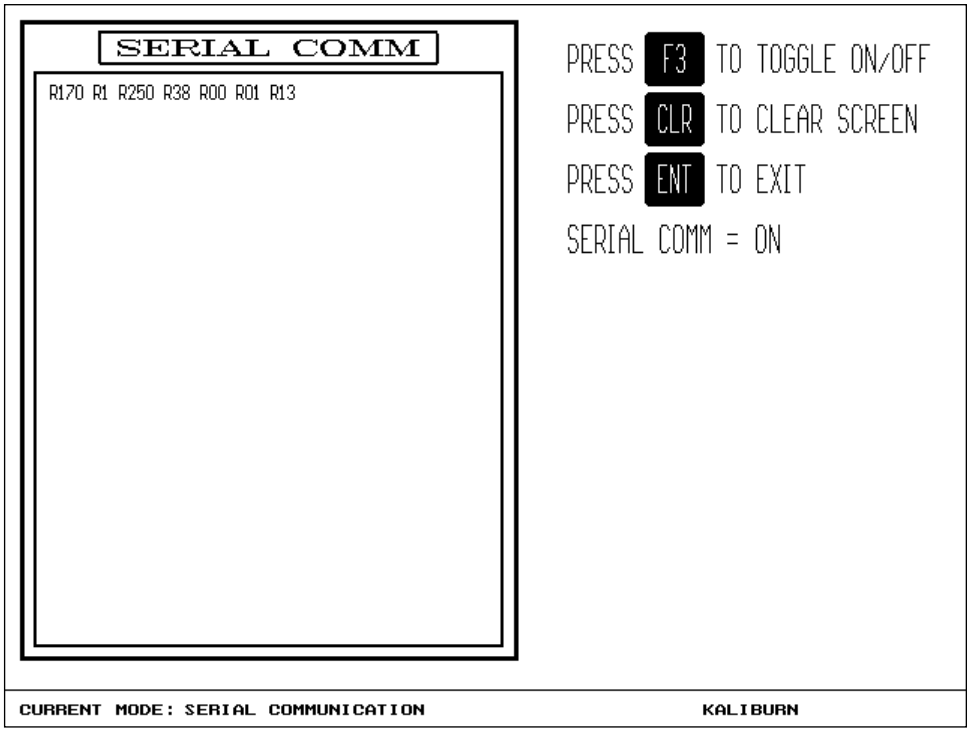
Viewing Serial Communications

To view the serial communication between the Spirit and an external device, scroll down to the View Serial Communication selection on the Maintenance screen and press enter. The Serial Communication screen will be displayed as shown. All incoming and outgoing data is displayed in decimal (base 10) format. Note that incoming data is appended to show an "R" before the data and outgoing transmissions are appended to show a "T" before the data. Pressing F3 will toggle the display on and off and pressing CLR will clear the screen.


SERIAL COMM
R170 R1 R250 R38 R00 R01 R13
PRESS F3 TO TOGGLE ON/OFF
PRESS CLR TO CLEAR SCREEN
PRESS ENT TO EXIT
SERIAL COMM = ON
CURRENT MODE: SERIAL COMMUNICATION
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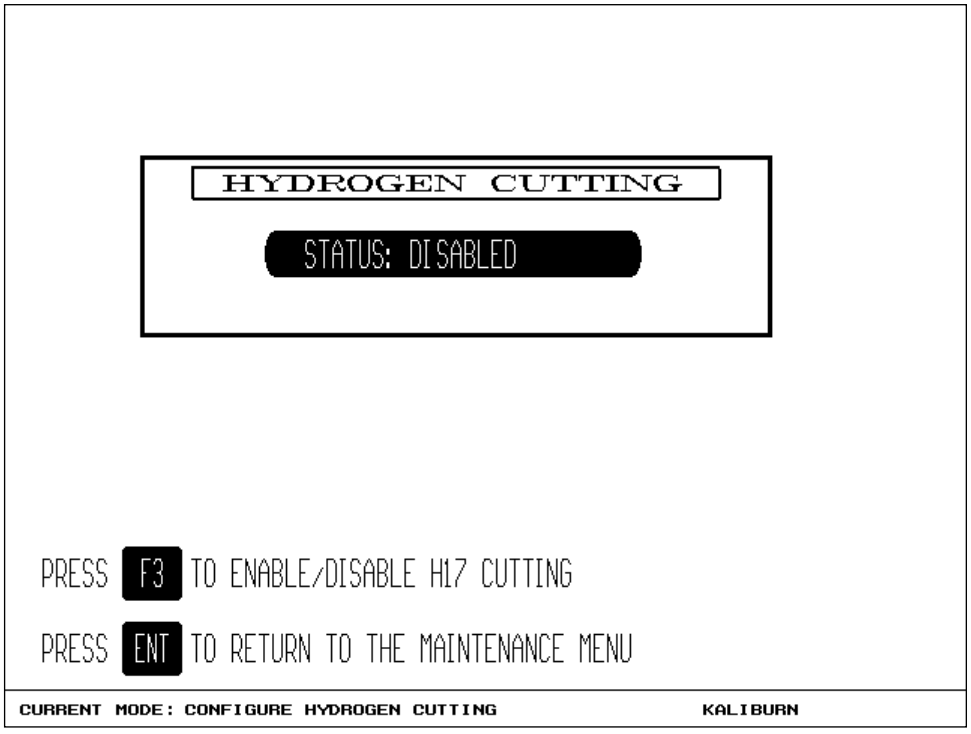
Configuring Hydrogen Cutting

When hydrogen cutting is enabled, the H17 hydrogen mixture will automatically be selected as the plasma gas for certain material types and thicknesses. To prevent the use of H17, hydrogen cutting must be disabled. To disable hydrogen cutting, scroll down to the Configure Hydrogen Cutting selection on the Maintenance Screen and press enter. The Configure Hydrogen Cutting screen will be displayed as shown. Pressing F3 will toggle the hydrogen cutting setting between enabled and disabled. When the desired selection is highlighted, press ENT.


HYDROGEN CUTTING
STATUS: DISABLED
PRESS F3 TO ENABLE/DISABLE H17 CUTTING
PRESS ENT TO RETURN TO THE MAINTENANCE MENU
CURRENT MODE: CONFIGURE HYDROGEN CUTTING
KALIBURN

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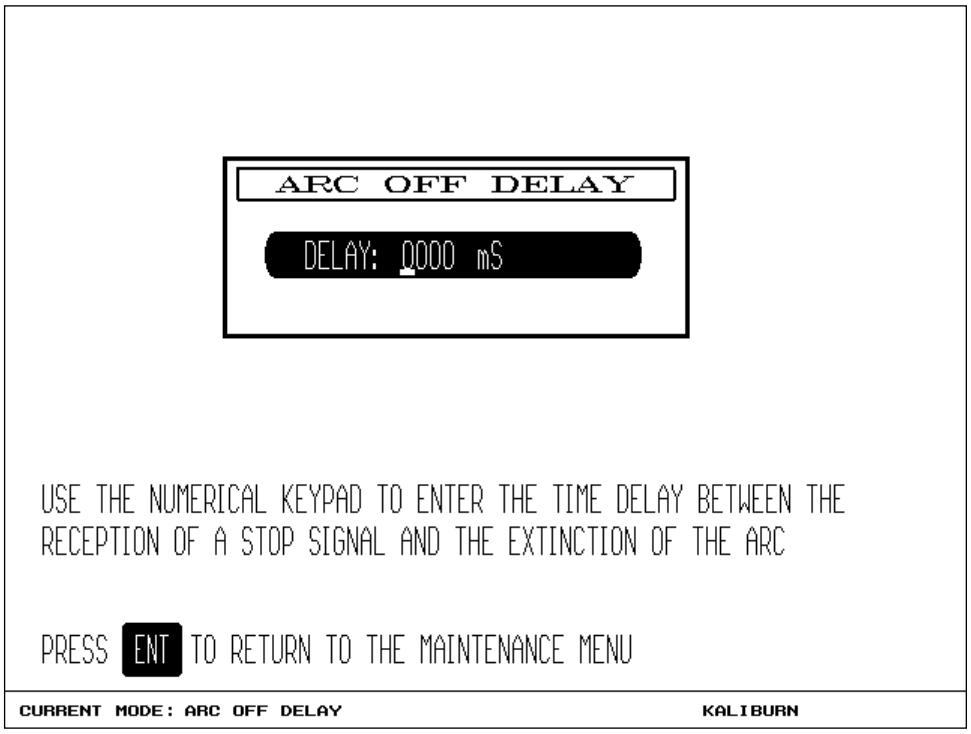
Setting an Arc Off Delay

In some instances, such as when cutting thicker stainless steel materials, it may be desirable to delay the extinction of the cutting arc after a stop signal is received. To program an arc off delay, scroll down to the Set Arc Off Delay selection on the Maintenance Screen and press enter. The Set Arc Off Delay screen will be displayed as shown. Use the keypad to enter the desired delay time in milliseconds. The delay can be set from 0 to 2000 mS.


ARC OFF DELAY
DELAY: 0000 mS
USE THE NUMERICAL KEYPAD TO ENTER THE TIME DELAY BETWEEN THE RECEPTION OF A STOP SIGNAL AND THE EXTINCTION OF THE ARC
PRESS ENT TO RETURN TO THE MAINTENANCE MENU
CURRENT MODE: ARC OFF DELAY
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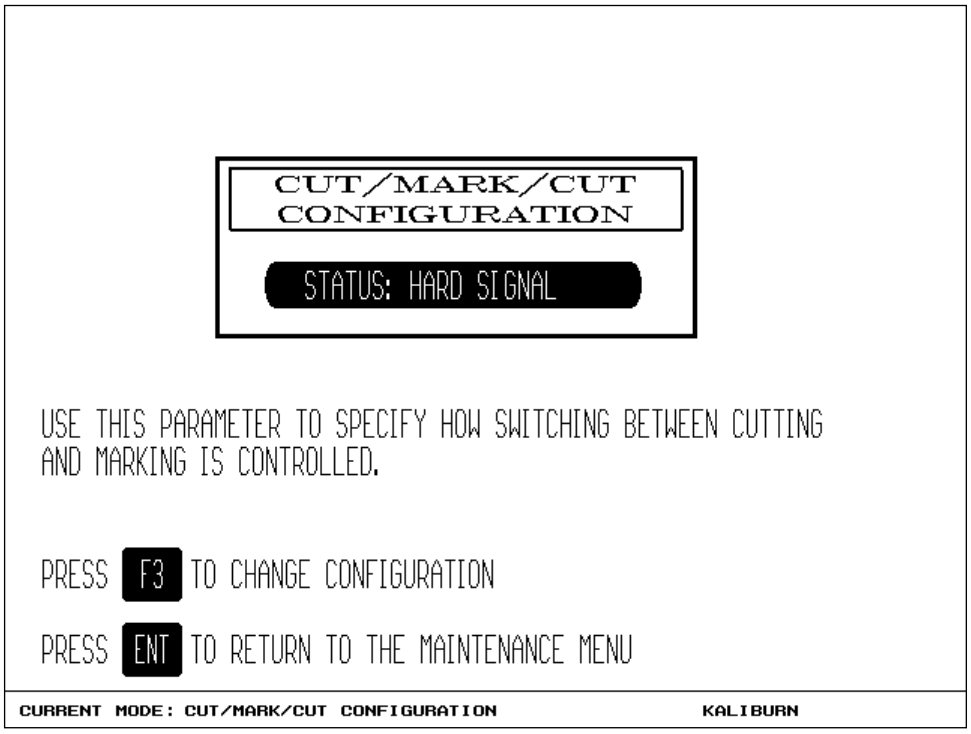
Switching Between Cutting and Marking

The Spirit system has the capability of plasma cutting and plasma marking with the same set of consumables. The process (cutting or marking) can be set by the RS-422 serial interface, by a hard signal on the CNC interface plug, or locally at the automatic gas console. To control how switching between processes is performed, scroll down to the Cut/Mark/Cut selection on the Maintenance Screen and press enter. The Cut/Mark/Cut Configuration screen will be displayed as shown. Pressing F3 will toggle the cut/mark/cut configuration between hard signal, RS-422, and local. When the desired selection is highlighted, press ENT.


CUT/MARK/CUT CONFIGURATION
STATUS: HARD SIGNAL
USE THIS PARAMETER TO SPECIFY HOW SWITCHING BETWEEN CUTTING AND MARKING IS CONTROLLED.
PRESS F3 TO CHANGE CONFIGURATION
PRESS ENT TO RETURN TO THE MAINTENANCE MENU
CURRENT MODE: CUT/MARK/CUT CONFIGURATION
KALIBURN

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Software Updates

The Automatic Gas Console has a floppy disk drive that is used to update the software as new revisions are released. To access the floppy disk drive, remove the floppy disk drive cover on the rear panel of the console. The software update may either be installed on one floppy disk or two floppy disks. Follow the instructions below for the appropriate update.

One-Disk Update

1. Remove primary power from the Spirit system.
2. Insert the floppy disk containing the software update into the floppy disk drive.
3. Apply primary power to the system and wait until the "AGC Updated Successfully" message appears.
4. Remove the floppy disk from the floppy disk drive.
5. Remove primary power from the system.
6. Reinstall the floppy disk drive cover.
7. Apply primary power to the system.

Two-Disk Update

1. Remove primary power from the Spirit system
2. Insert the first floppy disk containing the software update into the floppy disk drive.
3. Apply primary power to the system and wait until the "AGC Updated Successfully" message appears.
4. Remove the floppy disk from the floppy disk drive.
5. Remove primary power from the system, wait five seconds, then reapply primary power to the system.
6. Wait for the "Please Insert Update Disk 2" message to appear.
7. Install the second floppy disk containing the software update into the floppy disk drive.
8. Press any key on the keypad.
9. Wait for the "AGC Updated Successfully" message to appear.
10. Leave the second update disk in the floppy disk drive, remove primary power from the system, wait five seconds, then reapply primary power.
11. Wait for the "AGC Updated Successfully" message to appear.
12. Remove the floppy disk from the floppy disk drive.
13. Remove primary power from the system.
14. Reinstall the floppy disk drive cover.
15. Apply primary power to the system.

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Section 6 Serial Communication

Initializing the Spirit System

The Spirit system uses an RS-422 serial communication port located on the rear of the automatic gas console to receive and respond to commands that are transmitted from an x/y controller. The communications ground is isolated to prevent ground loops. System initialization is simple. Apply power, wait until the automatic gas console (AGC) has finished booting, then transmit the desired material type, material thickness, and optionally the process (cutting or marking) and the system will be ready for operation. All other parameters will be set to their default values and may be changed at any time.

Transmitting Parameters to the Spirit System

To transmit parameters to the Spirit, convert the following hex strings to 8 bit binary arrays (AA = 10101010) and transmit them using a 9600 baud RS-422 serial communication port. The port settings should have a start bit, one stop bit, and no parity. A table can be found in this section that lists the RS-422 commands and their descriptions. This table contains the necessary hex strings for sending different commands and parameters to the system. For example, to switch the material type from mild steel to stainless steel, look up the command for setting material type in the table. You will see the following table entry:

Command	#	Hex String	Additional Information
Set Material Type	1	AA nn FA 01 00 -- 0D	00 = Mild Steel – Hot Rolled 01 = Stainless Steel 02 = Aluminum 03 = Other 04 = Mild Steel – Cold Rolled

Note that spaces in the command string are shown for clarity only and should not be sent as part of the command. A command string always begins with the value AA hex. The "nn" is the net node (communication node) of the Spirit system that is to receive the command. The net node value of a system is set via the Set Communication Node selection on the maintenance screen. See Section 5 for detailed information on setting the net node. The value FA hex is the Spirit identifier. The value 01 hex is the value that signifies the Set Material Type command. The value 0D hex is the end of command character. In the above example, the following hex string would need to be transmitted to switch the material type to stainless steel for a Spirit system on node 1:

AA 01 FA 01 00 01 0D

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To send a parameter, the parameter value needs to be sent as part of the command. For example, to send a desired cutting pierce time of 1000 milliseconds to the system, look up the Set Cutting Pierce Time command in the command table. You will see the following table entry:

Command	#	Hex String	Additional Information
Set Pierce Time	4	AA nn FA 04 -- -- 0D	Time in mS (seconds / 1000) Valid range: 0 to 5000

Once again, AA hex signifies the start of the command, "nn" is the net node of the power supply, and FA hex is the Spirit identifier. The value 04 hex signifies the Set Cutting Pierce Time command, and 0D hex signifies the end of the command. The "-- --" in the hex string is the MSB followed by the LSB of a type **int**. The integer is the value used in the additional information column. Thus, the "-- --" is sometimes referred to as the additional information value. In the example, we wanted to transmit a Cutting Pierce Time of 1000 mS (1 second). This value in hexadecimal would be 03E8 (msb=03, lsb=E8). In this example, the following string would be transmitted in order to set the cutting pierce time to 1000mS for a power supply on net node 1:

AA 01 FA 04 03 E8 0D

For multiple power supply installations, commands can be sent to all power supplies at the same time. This is referred to as a global command. To send a global command, set the net node value to C8 hex (200 decimal). In the example above, the following string would be transmitted to set the Cutting Pierce Time to 1000mS for all power supplies connected on the network:

AA C8 FA 04 03 E8 0D

Communication Error Checking

With a single torch system, all commands and parameters transmitted to the Spirit will be back transmitted in exactly the same form for error checking. With a multiple torch system, only the system with node focus will back transmit the commands. The purpose of the node focus command (#254) is to allow one Spirit system to use the transmission lines at a time. If no node focus is set on initialization, the first system to receive a command will receive node focus automatically. Commands may be transmitted to systems without node focus, but there will be no back transmission from those systems. Also, all parameters can be read at any time by transmitting a Send Parameter command (#30) to the Spirit, followed by the appropriate parameter to be read.

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Default Cutting Parameters

In order to initialize parameters on a spirit system an external device must communicate, in sequence, the material type, material thickness, process (cutting or marking) and the cutting current. Once the Spirit system receives the cutting current, all other parameters will be set to their default values. Whenever the material type, material thickness, process or cutting current is changed, new default values will be retrieved for all other parameters. If a change is desired, cutting current must be sent last for the update to occur. To use non-standard parameter, first set the material type, material thickness, process and cutting current (in sequence), and then set the remaining parameter (i.e. pierce time) to the desired values.

Troubleshooting Serial Communication

When troubleshooting serial communication with the Spirit system, switch to the View Serial Communication Screen to view incoming and outgoing data. See Section 5 for information on the Serial Communication Screen.

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RS-422 Serial Commands

Note: In the following commands, "nn" represents the net node of the power supply that is to receive the command. To send a global command to all power supplies in a network configuration, "nn" should be set to C8 hex (200 decimal). The "-- --" in the hex string is the MSB followed by the LSB of a type int. The integer is the value found in the additional information column.

Command	#	Hex String	Additional Information
Set Material Type	1	AA nn FA 01 00 -- 0D	00 = Mild Steel – Hot Rolled 01 = Stainless Steel 02 = Aluminum 03 = Other 04 = Mild Steel – Cold Rolled
Set Thickness	2	AA nn FA 02 -- -- 0D	Thickness in mils (inches x 1000) Valid Range: 0 to 2000
Set Operating Current	3	AA nn FA 03 00 -- 0D	01 = 30A 02 = 50A 03 = 70A 04 = 100A 05 = 150A 06 = 200A 0A = 260A 0B = 275A 0C = 400A
Set Cutting Pierce Time	4	AA nn FA 04 -- -- 0D	Cutting pierce time in ms Valid Range: 0 to 9999
Set Preflow Pressure	6	AA nn FA 06 -- -- 0D	Preflow psi x 10 Valid Range: 0 to 1200
Set Plasma Gas Type	7	AA nn FA 07 00 -- 0D	00 = Oxygen 02 = Air 04 = H17
Set Plasma Pressure	8	AA nn FA 08 -- -- 0D	Plasma psi x 10 Valid Range: 0 to 1200
Set Shield Gas Type	9	AA nn FA 09 00 -- 0D	00 = Oxygen 01 = Nitrogen 02 = Air
Set Shield Pressure	10	AA nn FA 0A -- -- 0D	Shield psi x 10 Valid Range: 0 to 1200
Cutting Travel Speed	15	AA nn FA 0F -- -- 0D	If requested in command #30, the AGC will transmit the cutting travel speed in inches per minute. Range: 0 to 999

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Command	#	Hex String	Additional Information
Torch Body Part Number (msw)	16	AA nn FA 10 -- -- 0D	If requested in command #30, the AGC will transmit the most significant word of the torch body part number.
Torch Body Part Number (lsw)	17	AA nn FA 11 -- -- 0D	If requested in command #30, the AGC will transmit the least significant word of the torch body part number.
Torch Electrode Part Number (msw)	18	AA nn FA 12 -- -- 0D	If requested in command #30, the AGC will transmit the most significant word of the electrode part number.
Torch Electrode Part Number (lsw)	19	AA nn FA 13 -- -- 0D	If requested in command #30, the AGC will transmit the least significant word of the electrode part number.
Torch Swirl Ring Part Number (msw)	20	AA nn FA 14 -- -- 0D	If requested in command #30, the AGC will transmit the most significant word of the swirl ring part number.
Torch Swirl Ring Part Number (lsw)	21	AA nn FA 15 -- -- 0D	If requested in command #30, the AGC will transmit the least significant word of the swirl ring part number.
Torch Nozzle Part Number (msw)	22	AA nn FA 16 -- -- 0D	If requested in command #30, the AGC will transmit the most significant word of the nozzle part number.
Torch Nozzle Part Number (lsw)	23	AA nn FA 17 -- -- 0D	If requested in command #30, the AGC will transmit the least significant word of the nozzle part number.
Torch Retaining Cap Part Number (msw)	24	AA nn FA 18 -- -- 0D	If requested in command #30, the AGC will transmit the most significant word of the retaining cap part number.
Torch Retaining Cap Part Number (lsw)	25	AA nn FA 19 -- -- 0D	If requested in command #30, the AGC will transmit the least significant word of the retaining cap part number.
Torch Shield Cap Part Number (msw)	26	AA nn FA 1A -- -- 0D	If requested in command #30, the AGC will transmit the most significant word of the shield cap part number.
Torch Shield Cap Part Number (lsw)	27	AA nn FA 1B -- -- 0D	If requested in command #30, the AGC will transmit the least significant word of the shield cap part number.
Torch Outer Cap Part Number (msw)	28	AA nn FA 1C -- -- 0D	If requested in command #30, the AGC will transmit the most significant word of the outer cap part number.

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Command	#	Hex String	Additional Information
Torch Outer Cap Part Number (lsw)	29	AA nn FA 1D -- -- 0D	If requested in command #30, the AGC will transmit the least significant word of the outer cap part number.
Send Parameter	30	AA nn FA 1E -- -- 0D	01 = Send material type 02 = Send material thickness 03 = Send current set point 04 = Send cutting pierce time 05 = Send preflow gas type 06 = Send preflow pressure 07 = Send plasma gas type 08 = Send plasma gas pressure 09 = Send shield gas type 10 = Send shield gas pressure 15 = Send cutting travel speed 16 = Send torch body part number msw 17 = Send torch body part number lsw 18 = Send electrode part number msw 19 = Send electrode part number lsw 20 = Send swirl ring part number msw 21 = Send swirl ring part number lsw 22 = Send nozzle part number msw 23 = Send nozzle part number lsw 24 = Send retaining cap part number msw 25 = Send retaining cap part number lsw 26 = Send shield cap part number msw 27 = Send shield cap part number lsw 28 = Send outer cap part number msw 29 = Send outer cap part number lsw 32 = Send process select 33 = Send software version 34 = Send cutting chart version 35 = Send number of pierces 36 = Send number of pierce errors 42 = Send cutting arc voltage 43 = Send cutting height 44 = Send cutting pierce height 48 = Send cutting condition type 51 = Send arc off delay time 52 = Send machine type 53 = Send marking arc voltage 54 = Send marking height 55 = Send marking start height 56 = Send marking travel speed 57 = Send marking pierce time 59 = Send cut/mark/cut configuration
Set Process	32	AA nn FA 20 00 -- 0D	00 = Cutting 01 = Marking
Software Version	33	AA nn FA 21 00 -- 0D	If requested in command #30, the AGC will transmit the software version x 10.

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Command	#	Hex String	Additional Information
Cutting Chart Version	34	AA nn FA 22 00 -- 0D	If requested in command #30, the AGC will transmit the cutting chart version x 10.
Number of Pierces	35	AA nn FA 23 00 -- 0D	If requested in command #30, the AGC will transmit the number of pierces. Range: 0 to 9999
Number of Pierce Errors	36	AA nn FA 24 00 -- 0D	If requested in command #30, the AGC will transmit the number of pierce errors. Range: 0 to 9999
Reset Pierce Counter	37	AA nn FA 25 00 01 0D	Resets number of pierces and errors to 0
Power On	38	AA nn FA 26 00 01 0D	Energizes power supply, torch coolant pump and cooling fans. If torch coolant flow switch not satisfied within 8 seconds, unit will power down.
Power Off	39	AA nn FA 27 00 01 0D	Deenergizes power supply, torch coolant pump and cooling fans
Request System Status	40	AA nn FA 28 00 01 0D	System status can only be requested after a Power On command (#38) is transmitted. The status is returned in the following form: (All bits: 0=fault; 1=ok) LSB Bit 0 = RHF Door LSB Bit 1 = AC Power LSB Bit 2 = Coolant Flow LSB Bit 3 = Coolant Level LSB Bit 4 = Coolant Temp LSB Bit 5 = AGC status LSB Bit 6 = Inlet Gas Pressures LSB Bit 7 = Not used MSB Bit 0 = Not used MSB Bit 1 = Hydrogen Cutting Enabled
Purge Gases	41	AA nn FA 29 00 01 0D	Purges gas lines
Set Cutting Arc Voltage	42	AA nn FA 2A -- -- 0D	Sets cutting arc voltage in Volts x 100 Valid Range: 5000 to 20000
Set Cutting Height	43	AA nn FA 2B -- -- 0D	Sets cutting height in mils (inches / 1000) Valid Range: 0 to 999
Set Cutting Pierce Height	44	AA nn FA 2C -- -- 0D	Sets cutting pierce height in mils (inches / 1000) Valid Range: 0 to 999
Set Cutting Travel Speed	45	AA nn FA 2D -- -- 0D	Sets cutting travel speed (inches / min) displayed on the voltage screen Valid Range: 0 to 999
Save as User File	46	AA nn FA 2E 00 01 0D	Saves the present cutting conditions as a user file.

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Command	#	Hex String	Additional Information
Restore Factory Condition	47	AA nn FA 2F 00 01 0D	Restores the factory cutting condition for the present material type and thickness.
Cutting Condition Type	48	AA nn FA 30 00 -- 0D	If requested in command #30, the AGC will transmit whether the present cutting condition is a factory default setting or a custom user setting. Note: This is only valid when initially loading material type, thickness, and process. 0 = factory / 1 = custom
Configure H17 Cutting	49	AA nn FA 31 00 -- 0D	0 = Disable H17 cutting 1 = Enable H17 cutting
Reload Cutting Condition	50	AA nn FA 32 00 01 0D	Reloads the cutting conditions for the present material type and thickness
Set Arc Off Delay Time	51	AA nn FA 33 -- -- 0D	Sets the delay time in mS between the reception of a stop signal and the extinction of the arc. Valid Range: 0 to 2000 mS
Machine Type	52	AA nn FA 34 -- -- 0D	If requested in command #30, the AGC will transmit the machine type. 153 = Spirit150a 203 = Spirit200a 273 = Spirit275a 403 = Spirit400a
Set Marking Arc Voltage	53	AA nn FA 35 -- -- 0D	Sets marking arc voltage in Volts x 100 Valid Range: 5000 to 20000
Set Marking Height	54	AA nn FA 36 -- -- 0D	Sets marking height in mils (inches / 1000) Valid Range: 0 to 999
Set Marking Start Height	55	AA nn FA 37 -- -- 0D	Sets marking start height in mils (inches / 1000) Valid Range: 0 to 999
Set Marking Travel Speed	56	AA nn FA 38 -- -- 0D	Sets marking travel speed (inches / min) Valid Range: 0 to 999
Set Marking Pierce Time	57	AA nn FA 39 -- -- 0D	Sets marking pierce time in ms Valid Range: 0 to 9999
Configure Cut/Mark/Cut	59	AA nn FA 3B 00 -- 0D	0 = Local at power supply 1 = Hard signal via interface plug 2 = RS-422
Node Focus	254	AA C8 FA FE 00 nn 0D	Sends a global command to all systems and sets the node focus to system nn

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Section 7 Maintenance and Troubleshooting

WARNING: Only qualified maintenance personnel should perform maintenance on the Spirit system. The system utilizes potentially fatal A.C. and D.C. voltages. All maintenance should be performed with safety in mind.

Use extreme caution when working near the power conversion module (i.e., chopper). The large electrolytic capacitors store large amounts of energy even after power has been removed from the system. Wait at least five minutes after turning off power, and then use a voltmeter to verify that the capacitors are fully discharged before touching the power conversion module.

Capacitor failure can injure and/or cause property damage. If troubleshooting requires the system to be powered with the enclosure panels removed, remain clear of the capacitors. Failure of a capacitor can result in a sudden release of stored energy causing rupture of the capacitor case.

Routine Maintenance

Note: At minimum, these checks should be performed on a monthly basis. In excessively dirty environments or in heavy usage situations, the checks should be performed more frequently.

Power Supply

1. Remove the left, right, front, and rear panels of the power supply.
2. Using clean, dry, compressed air, blow out all accumulated dust inside the power supply, including dust on p.c. boards and fans. Be sure to blow out the fan and heat exchanger at the rear of the unit. In an excessively dirty environment, blow out the unit on a weekly basis.
3. Verify that all torch lead and work ground connections are secure and free from corrosion.
4. Verify that the primary three phase A.C. voltage connections are tight
5. Verify that all p.c. board connectors are installed securely.
6. Verify that the rear panel cable connectors are installed securely.
7. Verify that the automatic gas console connector is installed securely to the plug on the bottom of the gas console.
8. Check the torch coolant filter/deionization cartridge at the rear of the power supply and replace if dirty.
9. Flush the cooling system every six months and replace the coolant and coolant filter/deionization cartridge.

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Automatic Gas Console

1. Remove the cover of the automatic gas console.
2. Using clean, dry, compressed air, blow out all accumulated dust inside the unit. In an excessively dirty environment, blow out the unit on a weekly basis.
3. Verify that all p.c. board connectors are installed securely.
4. Verify that all gas hose connectors are tight and that there are no leaks. **Only tighten the gas fittings enough to make a gas seal. The fittings are subject to damage if over tightened**.
5. Inspect all gas hoses to ensure no damage exists. Immediately replace any damaged gas hoses.

Torch, Torch Leads, and Gas Hoses

1. Verify that all torch lead and gas hose connections are tight and that there are no gas or water leaks. **Only tighten the fittings enough to make a water or gas seal. The fittings are subject to damage if over tightened**.
2. Verify that the braided shield of the torch leads is fastened securely to the brass shield adapter that connects to the remote high frequency console. Also, make sure the shield adapter is secured tightly to the high frequency console enclosure.
3. Inspect the braided shield for nicks or cuts and replace if necessary.
4. Remove the torch handle and verify that the connections at the torch base are tightened securely. **Only tighten the fittings enough to make a water or gas seal. The fittings are subject to damage if over tightened**.
5. Make sure the torch lead insulating sleeves are positioned to properly cover the brass torch fittings at the rear of the torch base.
6. Inspect the outer sleeve on the torch base's electrode/coolant supply lead. If nicks, cuts or holes are found, replace the torch base.
7. Remove the torch consumables from the torch head and inspect all o-rings. Replace any o-rings with cuts, nicks, abrasions, or any other signs of wear. Faulty o-rings may cause gas or water leaks, which will affect cut quality.
8. With the electrode removed, inspect the cooling tube in the torch head for damage. If using a copper electrode, the torch head uses cooling tube P/N 277007. If replacement is required, use tool P/N 200109.

   If using a silver electrode, the torch head uses cooling tube P/N 279117 and cooling tube holder P/N 279116. Remove the cooling tube holder using tool P/N 277087 and inspect the o-rings for damage. Apply a small amount of o-ring lubricant before re-installing in the torch head.
9. Wipe any excess o-ring lubricant off of the torch base and head.

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Remote High Frequency Console

1. Open the cover of the RHF console and verify that all leads and hoses are tightened securely. **Only tighten the fittings enough to make a water or gas seal. The fittings are subject to damage if over tightened**.
2. Check the spark gap electrodes for signs of wear. Replace electrodes that have rounded faces. Use a clean feeler gauge and set the spark gap to .015" (.38 mm).

Work Ground

1. Verify that the work ground lead is securely fastened to the star ground on the cutting table, and that the connection point is free from corrosion. Use a wire brush to clean the connection point if necessary.

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Replacing the Torch Coolant

The torch coolant should be flushed out of the system every six months and replaced with new coolant. The following procedure should be used to prevent damage to the cooling system.

Note: When handling coolant, it is recommended that you wear nitrile gloves and safety glasses.

1. Remove primary power to the system.

2. Remove the rear cover of the power supply to expose the cooling system.

3. Remove the coolant reservoir cap/level gauge.

4. Make sure that consumables are properly installed in the torch head and that the torch head is installed on the torch base.

5. **Using a funnel to collect the coolant,** unscrew the drain petcock on the bottom of the coolant reservoir. Leave the funnel in place after the coolant drains out of the reservoir.

6. Remove the torch coolant supply hose from the rear of the power supply. Note that the coolant supply hose has right hand threads.

7. Blow compressed air (100 psi maximum) into the coolant supply hose. This will clear the coolant out of the torch, torch leads, and heat exchanger. Note that the coolant will be forced into the reservoir and will drain out of the drain petcock.

8. Unscrew the lower portion of the coolant filter housing and remove the coolant filter/deionization cartridge. Replace with a new filter.

9. Reconnect the coolant supply hose.

10. Refer to Section 3 for the remaining steps required for Filling the Torch Coolant Reservoir. **Only use Kaliburn approved torch coolant solution**. Commercially available antifreeze contains corrosion inhibitors that will damage the cooling system. See Section 3 for more information on Torch Coolant Requirements.

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Microprocessor Status LED's

The microprocessor p.c. board controls all of the functions of the Spirit system. It has diagnostic LED's which aid in troubleshooting the system. The LED's illuminate when a particular event occurs. Illuminated LED's indicate the following:

LED	Indication
OPTO 1 LED – PAR	Pilot Arc Relay Energized
OPTO 2 LED – CON	Main contactor CON1 energized
OPTO 3 LED - SURGE	CR3 and K1 relays energized
OPTO 4 LED - LATCH	Latch relay energized
OPTO 5 LED - PUMP	Coolant pump relay CR5 energized
OPTO 6 LED - 3 PHASE	Three phase power satisfactory
OPTO 8 LED – Aux 2	Power Supplied to ACG
OPTO 9 LED - HIGH FREQ	High frequency transformer TR5 energized
OPTO 10 LED - PREFLOW	Preflow gas valve 1 energized
OPTO 11 LED - PLASMA	Plasma gas valve 2 energized
OPTO 12 LED - SHIELD	Shield gas valve 3 energized
OPTO 13 LED - GSV4	Vent gas valve 4 energized
OPTO 14 LED – GSV5	Postflow gas valve 5 energized
OPTO 15 LED – MARKING	Marking gas valves 6 and 7 energized
LED 8 - START	Plasma start signal applied to Spirit
LED 9 - CHOPPER	Chopper energized
LED 10 - PAT	Pilot arc transistor energized
LED 11 - TAC	Transferred arc established from torch to workpiece
LED 12 - MOTION	Motion relay energized
LED 13 - HOLD IN	Arc hold input enabled
LED 14 - HOLD OUT	Power supply ready relay energized
LED 15 - MAN CONSOLE	Not used
LED 16 - 5V uP PWR	5V microprocessor power supply satisfactory
LED 17 - 12V uP PWR	12V microprocessor power supply satisfactory
LED 18 - ILK PWR	12V interlock power supply satisfactory
LED 19 - ANALOG PWR	15V analog power satisfactory
LED 20 - GAS PWR	24V gas solenoid power satisfactory
LED 21 - OVER CURRENT	Over current / power down to reset
LED 22 - ERROR	Blinks on and off to display error codes
LED 28 - COMM PWR	5V communication power supply satisfactory
LED 29 –15V	-15V analog power satisfactory
LED 30 - XMIT	Indicates serial transmission to AGC
LED 31 - RECV	Indicates serial transmission from AGC

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Microprocessor Sequence of Operation

The following LED's should illuminate after primary power is applied:

- OPTO 8 LED - Aux 2
- LED 16 - 5V uP PWR
- LED 17 - 12V uP PWR
- LED 18 - ILK PWR
- LED 19 - ANALOG PWR
- LED 20 - GAS PWR
- LED 28 - COMM PWR
- LED 29 - 15V

The following LED's should illuminate when the ON button is depressed:

- OPTO 6 LED - 3 PHASE
- OPTO 5 LED - PUMP
- OPTO 4 LED - LATCH

The following LED's should illuminate in sequence after a start signal is received in the cutting mode:

- LED 8 - START
- OPTO 10 LED - PREFLOW
- OPTO 12 LED - SHIELD
- OPTO 3 LED - SURGE (OPTIONAL)
- OPTO 2 LED – CON
- OPTO 1 LED - PAR
- LED 10 - PAT
- LED 9 - CHOPPER
- OPTO 9 LED - HIGH FREQ
- LED 11 - TAC
- OPTO 11 LED - PLASMA
- OPTO 14 LED - GSV5
- LED 12 - MOTION

After a transferred cutting arc is established, the following LED's will go out:

- OPTO 9 LED - HIGH FREQ
- OPTO 10 LED - PREFLOW
- LED 10 - PAT

When the start signal is removed, OPTO 11 LED - PLASMA will extinguish and OPTO 13 LED - GSV4 will illuminate and then go out with the rest of the cut cycle LED's.

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Troubleshooting Using the Control Panel Status LED's

If the Spirit system develops a problem, first check the control panel status LED's. If one or more of the LED's does not illuminate after the ON button is depressed, use the status LED's to pinpoint the problem.

- **RHF Door LED** - Extinguishes when the RHF door switch opens. Check the RHF door, switch, and associated wiring.
- **Gas Console LED** - Extinguishes when there is a problem with the gas console or when the unit is adjusting gas pressures. Switch to the messages screen on the gas console to pinpoint the problem.
- **3 Phase Power LED** - Extinguishes when there is a problem with the three phase power being supplied to the chopper assembly. Verify that the primary wall disconnect fuses are good and check the main transformer, main contactor and A.C. Detect p.c. board for proper operation. Also, this LED should turn on immediately when the green "ON" button is pressed. If not, check P28-3 to P28-4 for 10 VDC first. This should drop to 0 VDC when the ON button is pushed. If not, then check CR1 and associated wiring.
- **Coolant Flow LED** - Extinguishes when there is a problem with the torch coolant system. Check the coolant pump fuse F2 and verify that 230VAC is present between TB3-13 and TB3-14. Also check for clogs in the coolant leads and coolant filter/deionization cartridge.
- **Coolant Level LED** - Extinguishes when the coolant level in the tank has dropped below the required minimum level. Add more coolant to clear the error.
- **Coolant Temperature LED** - Extinguishes when the coolant temperature has risen above the maximum operating temperature. Ensure that the heat exchanger fan is running and that the heat exchanger is free from dust. Blow out the heat exchanger and fan with clean, dry, oil-free compressed air. Leave the unit running until the LED illuminates.

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Troubleshooting Using the Automatic Gas Console Messages Screen

If all of the status LED's are illuminated but the Spirit system still has a problem, switch to the messages screen on the automatic gas console (see Section 5 for specific instructions on switching to the messages mode). The gas console may display information that is useful in pinpointing the problem. While the automatic gas console is displaying an error message, the power supply microprocessor displays an error code by blinking LED22 on and off to indicate that an error has occurred. The number of blinks can be counted to determine which error has occurred. The following chart lists the errors and the corresponding number of blinks.

LED22 Number of Blinks	Error
1	No transferred arc (TAC) established
2	TAC lost before current slope up
3	TAC lost during current slope up
4	TAC lost while cutting
5	TAC lost during current slope down
6	Start signal applied prematurely
7	Start signal removed prematurely
8	Output voltage below 60V
9	Output voltage above 210V
10	Invalid current set point
11	Current feedback circuit open
12	TAC not established within 2 seconds
13	Arc hold timed out
14	Pilot arc not established
15	Low current during cut
16	TAC sensed when start signal applied
17	Faulty AC phase
18	Low torch coolant flow
19	Gas console error
20	RHF door switch open
21	Low torch coolant level
22	High torch coolant temperature
23	Main contactor shorted
24	AGC Fan not operational
25	Defective Flow Switch

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General Troubleshooting

The following chart lists general troubleshooting guidelines for the Spirit system when the status LED's or the automatic gas console messages screen do not give any insight to the particular problem being experienced. Please contact KALIBURN technical support for any issues not covered in this section. Before any tests are performed, make sure that all system fuses are good. The primary system fuse F1 is located on the rear panel of the unit. All of the control fuses are located behind the front panel of the unit beside the microprocessor p.c. board. The automatic gas console fuse is located behind the right side panel of the system. Also check all of the voltage LED's on the system p.c. boards before performing any tests.

Problem	Possible Cause
Front panel white A.C. power light will not illuminate	1. Primary disconnect fuse blown. 2. Fuse F1A, F1B, or F4 blown. 3. White light or associated wiring bad. 4. Transformer TR2 or associated wiring bad.
Unit will not energize when the ON button is pressed	1. RHF door open. 2. Low coolant level. 3. Fuse F4 blown. 4. Faulty ON switch or associated wiring. The ON switch is normally open. 5. Faulty OFF switch or associated wiring. The OFF switch is normally closed. 6. Relay CR1 coil open.
Power supply will not stay on when the front panel ON button is pressed and released	1. Check the control panel status LED's and troubleshoot accordingly. 2. Check the gas console messages screen and troubleshoot accordingly. 3. Faulty latch relay on relay p.c. board. 4. Faulty relay p.c. board. 5. Faulty microprocessor p.c. board. 6. Relay CR1 defective.
No arc at the torch	1. Incorrect torch consumables installed. 2. Incorrect gas pressure settings. 3. Check the control panel status LED's and troubleshoot accordingly. 4. Check the spark gap assembly inside the RHF console for proper arcing after a start signal is applied. Open the RHF door and pull up on the door interlock switch plunger to defeat the interlock. If there is no spark, skip to the next test.

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Problem	Possible Cause
	5. Check the automatic gas console messages screen and troubleshoot accordingly. If the "output voltage low" error is present, perform the chopper test in this section. 6. Pilot arc transistor PAT is not operating properly. Check the PAT LED's on the microprocessor p.c. board and PAT drive p.c. board. 7. Damaged or loose torch lead connections. 8. Shorted torch or torch leads. Check the continuity between the Electrode lead and the Nozzle lead to make sure they are not shorted. 9. Open torch or torch leads. Check the continuity from the Electrode lead to the torch electrode and the Nozzle lead to the large brass body of the torch.
No spark between the spark gap electrodes	1. Improper spark gap. Set gap to .015" (.381 mm). 2. Worn spark gap electrodes. Clean electrodes with 600 grit sandpaper and regap. Replace electrodes that have a rounded face. 3. Bad high frequency transformer TR5. Check for signs of arcing. 4. Check for 120VAC on the input side of filter FL1 inside the RHF console after a start signal has been given. If 120V is not present, check associated wiring back to the power supply.
The arc will not transfer to the workpiece	1. Loose work ground connection. 2. Pierce height too high. 3. Incorrect, damaged, or worn consumables.
The gas console screen is blank	1. Blown gas console fuse F10. 2. Loose cables inside the gas console. Remove and reinstall all plugs on the interface p.c. board, computer, video board, and display. 3. Bad power supply inside gas console. Check for all voltage LED's on the interface board and computer. 4. Loose plug P17 on the bottom of the gas console. Remove and reinstall the plug.
No response from the gas console keypad	1. Loose keypad cable inside the gas console. Remove and reinstall the keypad cable.

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Problem	Possible Cause
Gas pressures will not adjust properly	1. Wrong consumables installed in torch. 2. Loose pressure transducer cable. Remove and reinstall P8 and P9 on the gas console I/O p.c. board. 3. Loose motorized regulator plugs. Remove and reinstall the motor plugs and P4-P7 on the gas console I/O p.c. board. 4. Pressure regulator orifice clogged with dirt or debris. Turn off primary power and turn motorized regulator screw all the way in by hand. 5. Binding regulator. Turn off primary power and turn all motorized regulators to their mid positions by hand. 6. Loose shield valve plug. Remove and reinstall P3 on the gas console I/O p.c. board.
Low pressure error	1. Supply gas pressure(s) less than 120 psi. 2. Faulty pressure switch or associated wiring inside gas console.
Pressure error during cut	1. Supply gas pressure(s) fluctuating during cut.

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Chopper Test Procedure

WARNING: Only qualified maintenance personnel should perform the chopper test procedure. The system utilizes potentially fatal A.C. and D.C. voltages. All maintenance should be performed with safety in mind.

Use extreme caution when working near the power conversion module (i.e., chopper). The large electrolytic capacitors store large amounts of energy even after power has been removed from the system. Wait at least five minutes after turning off power, and then use a voltmeter to verify that the capacitors are fully discharged before touching the power conversion module.

Capacitor failure can injure and/or cause property damage. If troubleshooting requires the system to be powered with the enclosure panels removed, remain clear of the capacitors. Failure of a capacitor can result in a sudden release of stored energy causing rupture of the capacitor case.

Note: A chopper troubleshooting flow chart can be found at the end of this section.

1. Turn off all power to the Spirit power supply.
2. Open the RHF console door and disconnect the black primary wires of the high frequency transformer from the 120 VAC line filter. Close the RHF console door to activate the door interlock switch.
3. Remove the front and left side panels from the power supply to expose the output terminal block and the microprocessor p.c. board.
4. Remove the Electrode and Nozzle leads from the **bottom** connections of the output terminal block (#59 & #79, page 8-5).
5. Apply three phase power to the unit and check the primary power on the input terminal block TB5.
6. Depress the ON button to energize the Spirit system, and then apply a start signal to the unit. **Note that the unit will only energize for approximately two seconds each time a start signal is applied. When making the following readings, be sure the red DC Power light is illuminated on the front control panel of the unit**. After applying the start signal, check the three phase voltage input to the chopper at the diode bridge terminals (three right side screws on the chopper assembly) for 225 VAC. If the voltage is not present, check for primary voltage on the main contactor CON and on the primary side of the power transformer.
7. With a start signal applied, check for 325 VDC at the Spirit output terminal block between Electrode and Work. If 325 VDC is present, the chopper is working properly.

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8. If 325 VDC is not present at the output terminal block, install a jumper wire between P28-7 & P28-8 (ILK1). With a start signal applied, check for 325 VDC at the Spirit output terminal block between Electrode and Work. If 325 VDC is present, the chopper is working properly. Check the I/O PCB (HV- Output) and its wiring to the Microprocessor PCB.

9. If 325 VDC is not present at the output terminal block, leave the jumper wire installed between P28-7 & P28-8 (ILK1). Check the chopper status LED's when a start signal is applied:
   a) LED's 4 & 5 off - go to step 10.
   b) LED's 4 & 5 on, LED 6 off - go to step 11.
   c) LED's 4 & 5 on, LED 6 on, LED 7 off - go to step 12.
   d) Only LED 4 or LED 5 on (not both) - replace chopper.
   e) All LED's on – replace chopper.

10. Check the 120 VAC supply to the chopper between P1-1 and P1-3 on the chopper p.c. board. If 120 V is present, replace the chopper. If 120 V is not present, check fuse F3 and associated wiring.

11. Apply a start signal to the power supply and check the DC voltage between P2-4 (ground) and P2-5 (signal) on the chopper p.c. board. This voltage should change from approximately 15.5 VDC to less than 1 VDC after the main contactor of the power supply is energized. If 15.5 VDC is not present, replace the chopper. If no voltage change occurs, check for approximately 15.5 VDC between P26-1 (ground) and P26-2 (signal) on the microprocessor p.c. board. If 15.5 VDC is not present, check continuity between P26 on the microprocessor p.c. board and P2 on the chopper p.c. board. If 15.5 VDC is present at the microprocessor p.c. board, replace the microprocessor.

12. **Turn off primary power to the power supply**. Disconnect P2 from the chopper p.c. board and P26 from the microprocessor p.c. board. Check continuity between P26-8 and P2-1 and between P26-7 and P2-2. Also check that these wires are not shorted to each other. If the cable is OK, connect P26 to the microprocessor p.c. board, but leave P2 disconnected from the chopper. With power applied, give the power supply a start signal and check for approximately 10 VDC between P26-7 (ground) and P26-8 (signal) when the main contactor is energized. If 10 VDC is not present, replace the microprocessor p.c. board. If 10 VDC is present, turn all power off, reconnect P2 to the chopper p.c. board, and repeat the test for 10 VDC between P2-2 (ground) and P2-1 (signal). If 10 VDC is present and LED 7 is not illuminated, replace the chopper.

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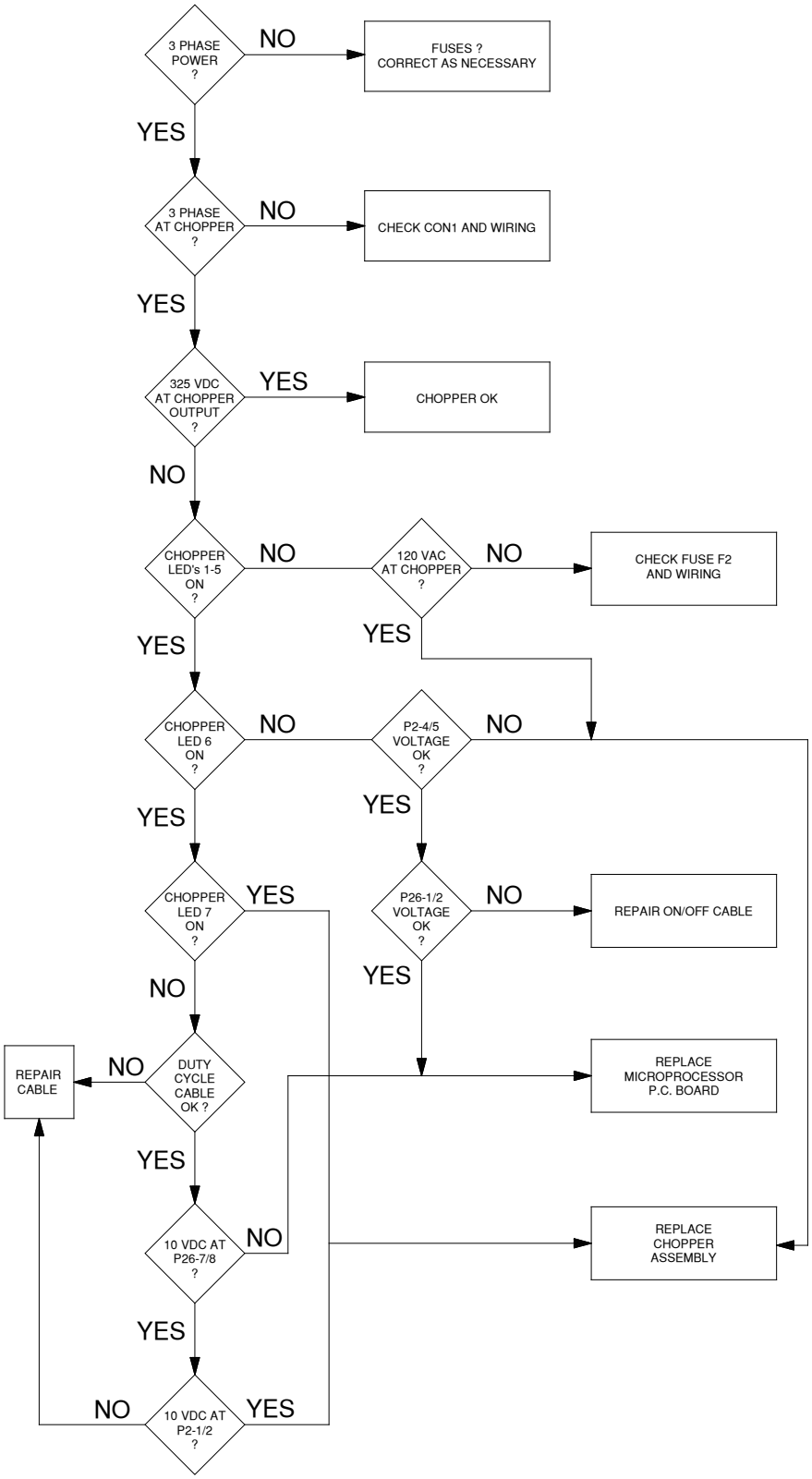

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Section 8 Parts List

Power Supply

Note: See Figures Below

Item Number	Part Number	Quantity	Description
1	708088	1	Off switch, red
2	708111	1	Off actuator, red
3	708090	1	On switch, green
4	708089	1	On actuator, green / illuminated
5	501163	2	Light housing
6	501164	2	Bulb
7	501162	1	White lens
8	501161	1	Red lens
12	707260	1	L1 inductor
13	500557	1	TR2 control transformer, 208/230/460 V / 60 Hz
	706205		TR2 control transformer, 575 V / 60 Hz
	500559		TR2 control transformer, 380/415 V / 50/60 Hz
14	706264	1	TR1 main transformer, 208 V / 60 Hz / 3Ø
	706263		TR1 main transformer, 230 V / 60 Hz / 3Ø
	706262		TR1 main transformer, 380 V / 50/60 Hz / 3Ø
	706261		TR1 main transformer, 415 V / 50/60 Hz / 3Ø
	706260		TR1 main transformer, 460 V / 60 Hz / 3Ø
	706265		TR1 main transformer, 575 V / 60 Hz / 3Ø
15	709086	4	TB1 – TB4 terminal block marker, 14 position
16	709007	4	TB1 – TB4 terminal block, 14 position
17	709058	10	F2-F11 fuse holder
18	709012	1	F10 fuse, AGC 3A fuse
19	709011	2	F3/F4 fuse, AGC 5A
20	709059	1	F8 fuse, AGC 2A
21	709076	4	F6/F7/F9/F11 fuse, AGC 1/2A
22	709033	1	F5 fuse, AGC 1A
23	280275	1	Microprocessor p.c. board assembly
24	709002	3	P8/P12/P13, 14 socket receptacle
25	709001	1	P7, 4 pin receptacle
26	709124	1	P16, 9 socket receptacle
27	709061	2	F1A/F1B fuse holder
28	709128	2	F1A/F1B fuse, FNM 6.25A
29	709060	1	Strain relief
30	500810	1	A.C. detect p.c. board assembly
31	200092	1	Coolant reservoir, without fittings or cap
Not shown	200292	1	Coolant reservoir assembly, with fittings and cap
32	500518	1	Coolant reservoir cap/level gauge
33	708062	1	LS1 coolant level switch
34	505024	1	TS1 Coolant temperature switch
35	500052	1	Pump motor, 1/3hp-230V-50/60 Hz

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Item Number	Part Number	Quantity	Description
36	500513	1	V-band clamp
37	500511	1	Coolant pump, 70 gph
38	708061	1	Solenoid valve, 220/240VAC
39	715084	1	Check valve, coolant return
40	708068	2	CR2/CR5 relay
41	708059	1	FS1 coolant flow switch
42	500516	1	Fan, front panel
43	260250	1	Heat exchanger
44	260012	1	Shunt
45	500509	1	Coolant filter housing
46	500510	1	Coolant filter/deionization cartridge
47	708117	1	CON main contactor
48	500348	1	Relay p.c. board assembly
49	702076	1	EMI filter, 380/415 V units only
50	708118	2	CR3/PAR relay
51	701165	2	R7/R8, 3 ohm pilot arc resistor
52	500536	1	PAT IGBT drive p.c. board assembly
53	705011	1	PAT IGBT
54	709167	1	TB5 3Ø power terminal block
55	702075	2	PAT IGBT filter capacitor
56	277452	1	I/O p.c. board assembly
57	Contact factory	1	Height control voltage divider p.c. board assembly
58	280130	1	Chopper assembly
59	709117	1	I/O terminal block (small)
62	706036	1	TR8 transformer, 241-4-36
63	706041	2	TR4/TR7 transformer, 241-3-12
64	706042	1	TR5 transformer, 241-4-12
65	706043	1	TR3 transformer, 241-6-12
66	280003	1	Power supply, 24VDC
67	708103	1	CR1 relay
68	708104	1	CR1 relay socket
69	708105	1	CR1 hold-down clip
72	709190	1	TB6 terminal block marker, 4 position
73	709191	1	TB6 terminal block, 4 position
74	740106	1	Bulb, power on switch
75	704050	6	LED/lens, green
76	200204	1	Fan, 120V
77	715052	1	Drain petcock
78	500526	2	Fan guard (large) – outside
	500574	2	Fan guard (small) - inside
79	709228	1	I/O terminal block (large)
80	709227	2	Strain relief
81	709231	1	F2 fuse, MDL 5A
82	500525	4	Fan, heat exchanger / front panel
83	701141	1	R9, 2 ohm pilot arc resistor

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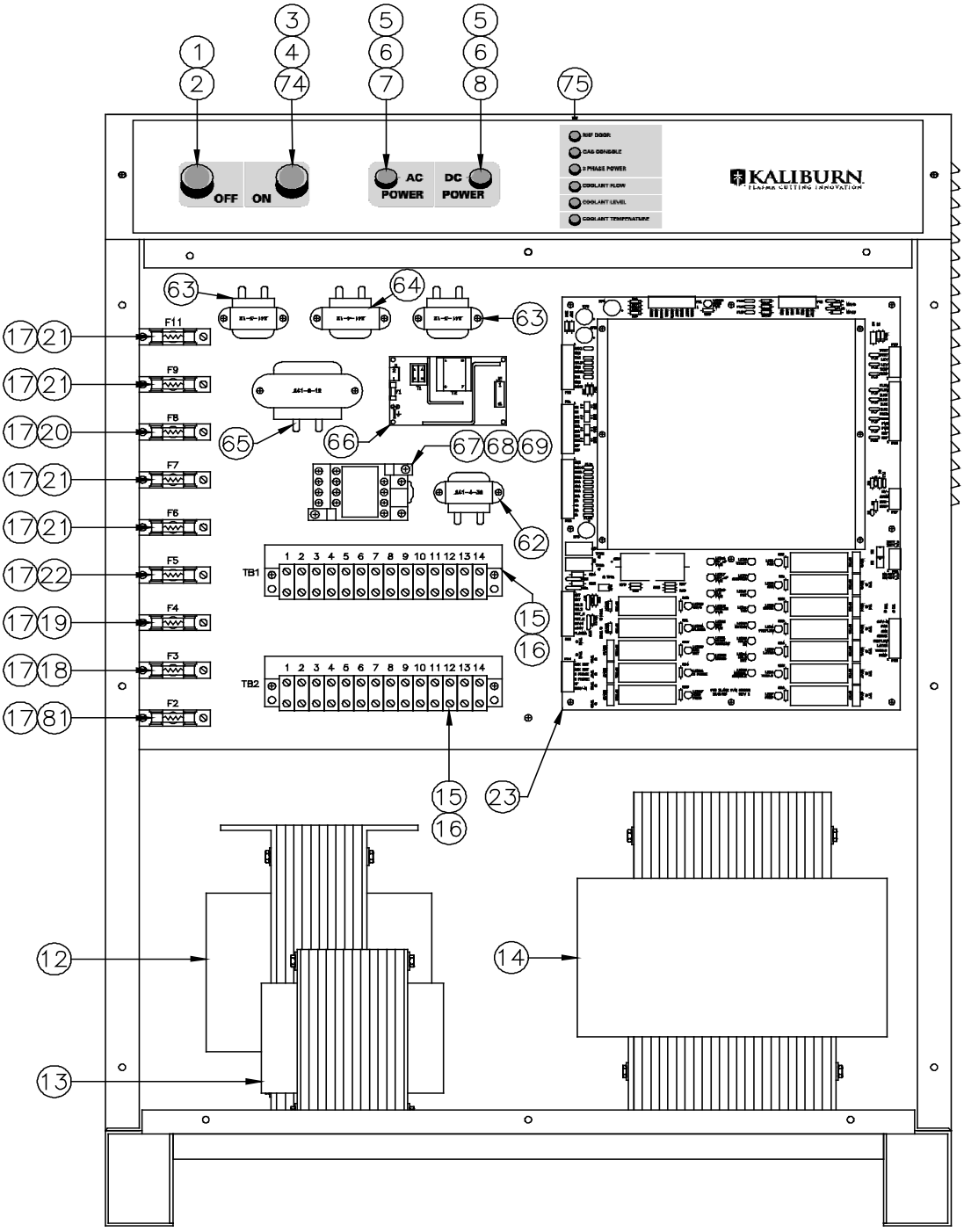
Power Supply – 1 of 4



Front panel fans not shown (item numbers 42 and 82)

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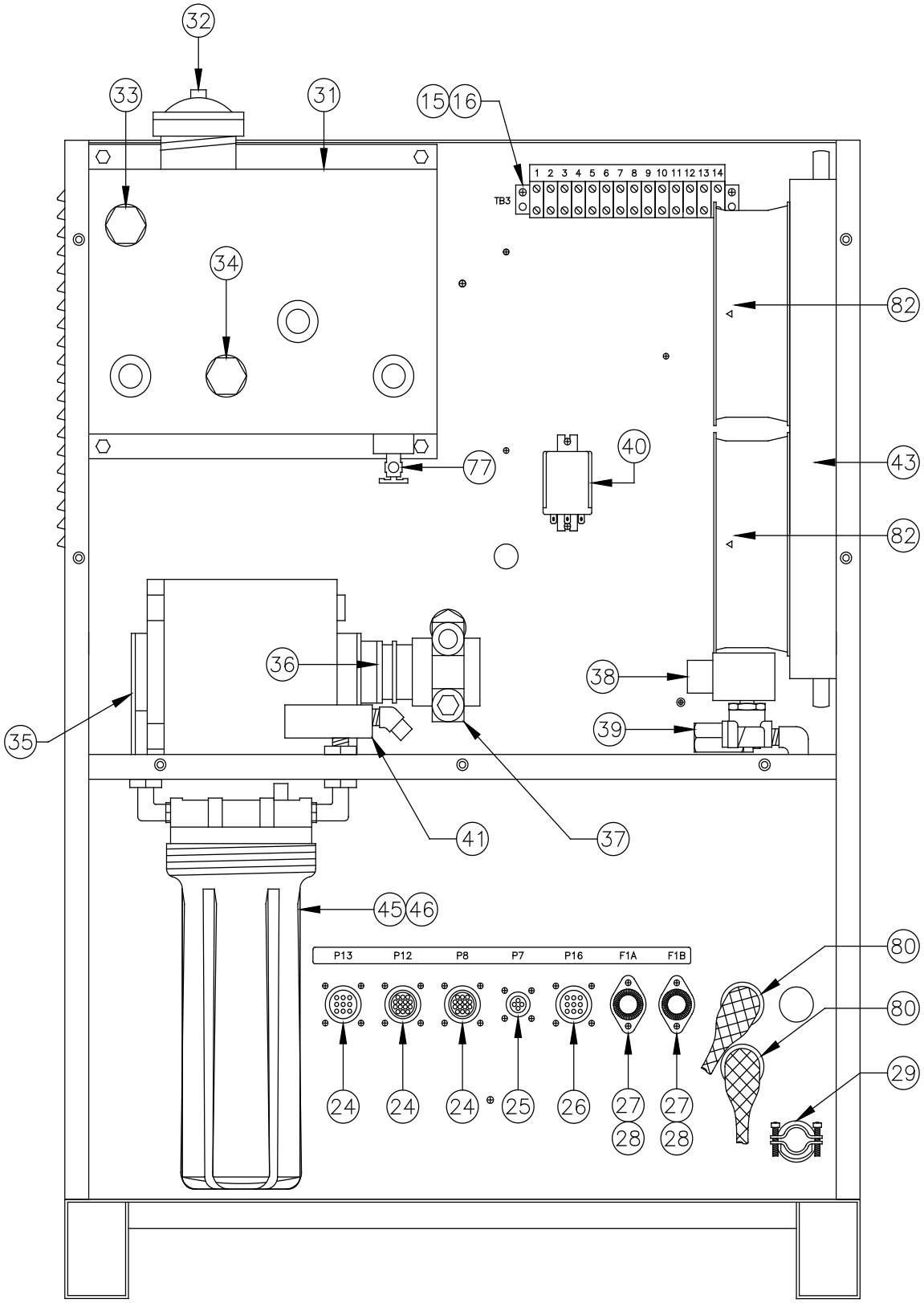
Power Supply – 2 of 4



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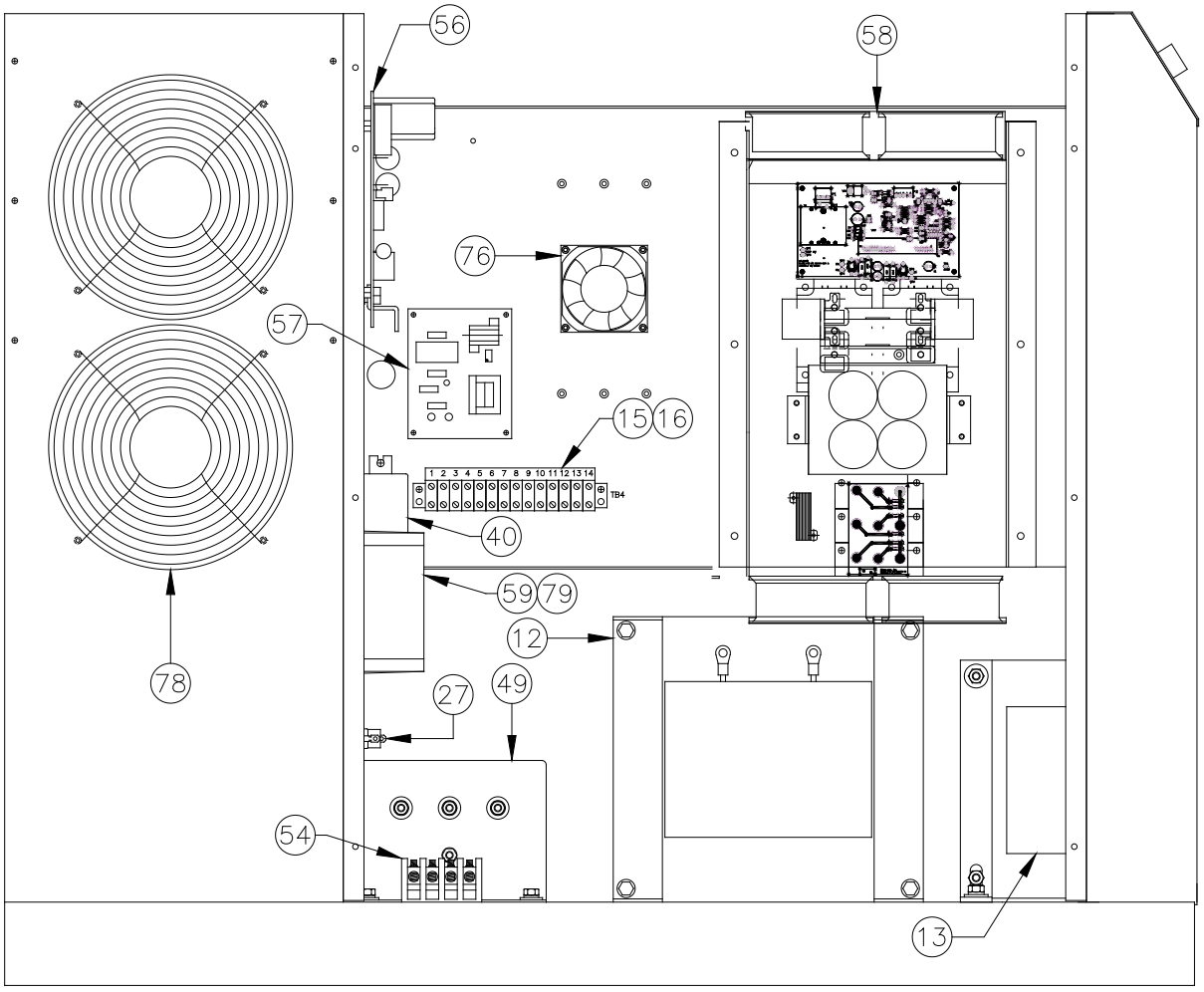
Power Supply – 3 of 4



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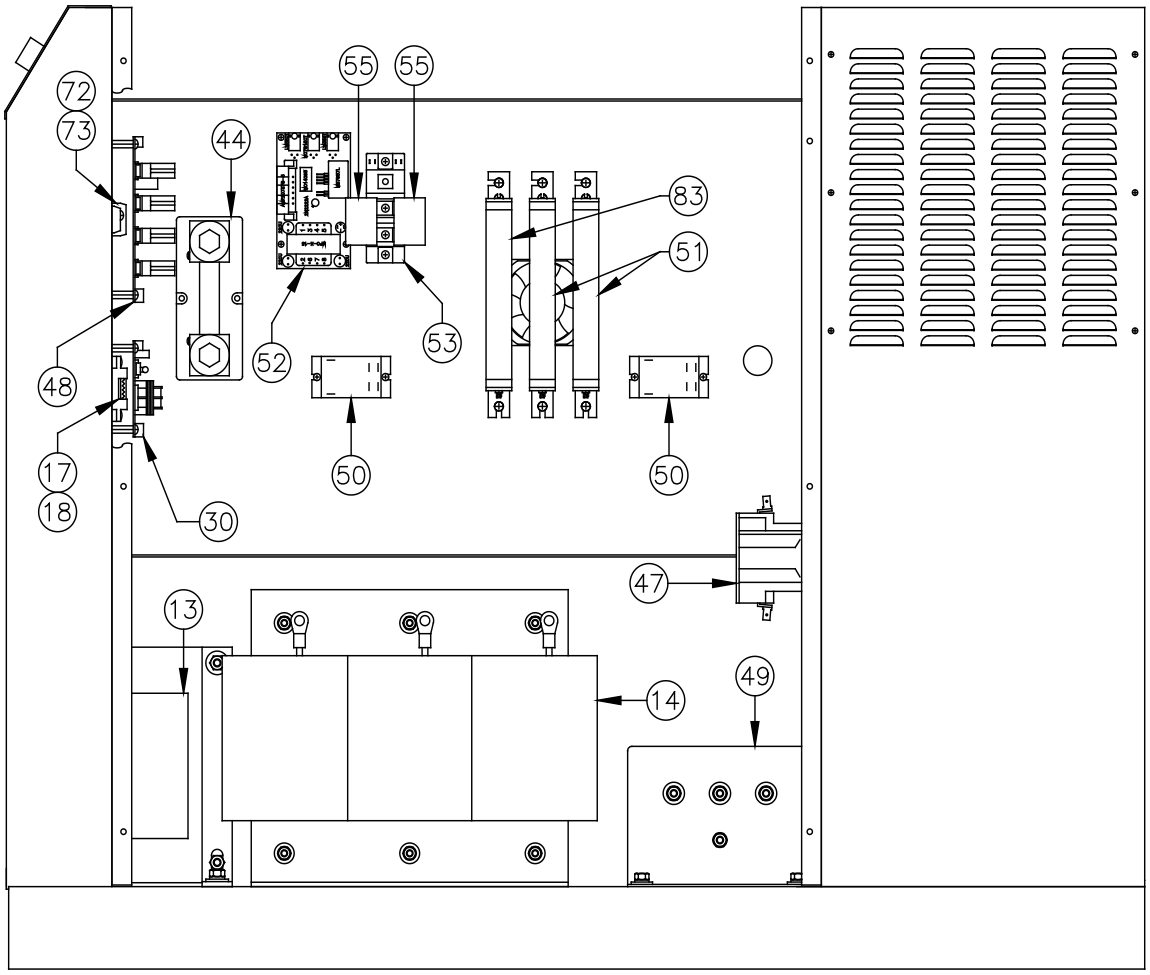
Power Supply – 4 of 4



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Automatic Gas Console (Assembly 280002)

Note: See Figures Below

Item Number	Part Number	Quantity	Description
1	280005	1	AGC decal / membrane switch
2	501146	1	AGC aluminum display panel
3	500860	1	AGC display window
4	710199	4	Aluminum standoff
5	500861	1	AGC EL display
6	706044	1	Transformer, 241-7-16
9	709003	2	Receptacle, 9 position
10	700404	1	Filter bracket
11	702037	5	Filter
12	709179	1	Terminal block, 10 position
13	709192	1	Terminal block marker, 10 position
14	505039	1	Floppy disk drive
15	500021	1	Floppy disk drive cover
Not shown	505047	1	Floppy disk drive cable
16	501145	9	Manifold
17	708097	4	Pressure switch, 80-200 psi
18	715097	6	Transducer isolator
19	260217	5	Solenoid valve
20	500867	3	Motorized regulator assembly
22	500868	1	Motorized regulator assembly, oxygen
23	709007	1	Terminal block, 14 position
24	709009	1	Terminal block marker, 14 position
25	200082	1	Solenoid valve assembly, 3 gang
26	500907	1	Solenoid valve bracket
27	200083	1	Solenoid valve assembly, 4 gang
28	501170	1	Power supply
29	505041	1	Video card (upper p.c. board)
30	280049	1	CPU (middle p.c. board)
31	200288	1	I/O p.c. board assembly (lower p.c. board)
Not shown	280286	1	Video card / CPU / I/O p.c. board assembly
33	280001	1	Regulator
34	708078	6	Transducer, 0-150 psi
35	280007	1	Pressure gauge, 0-60 psi
36	260111	1	Proportional valve amplifier
37	260109	1	Proportional valve
38	260104	1	Power supply
39	280030	1	Fan
40	280031	1	Fan Guard

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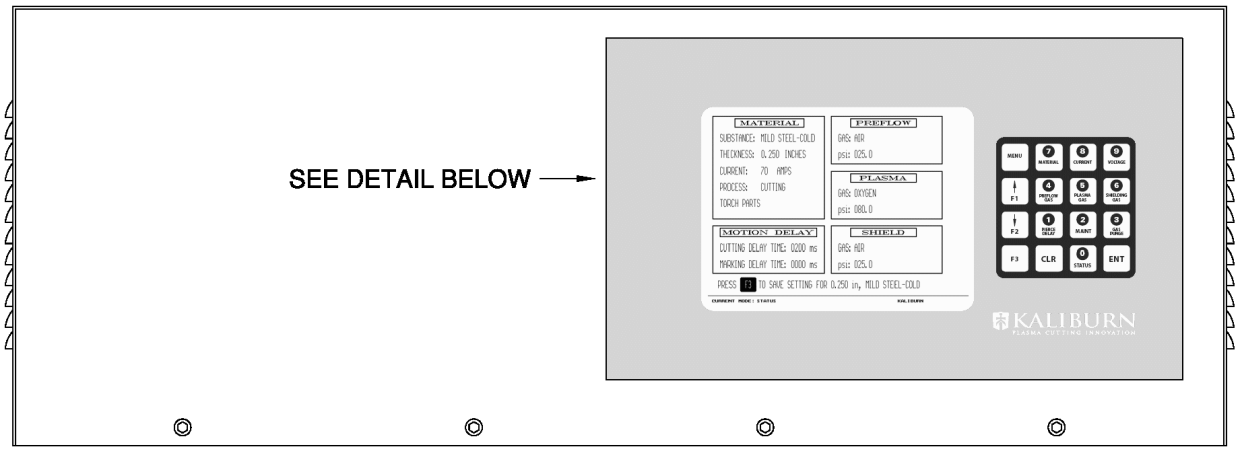
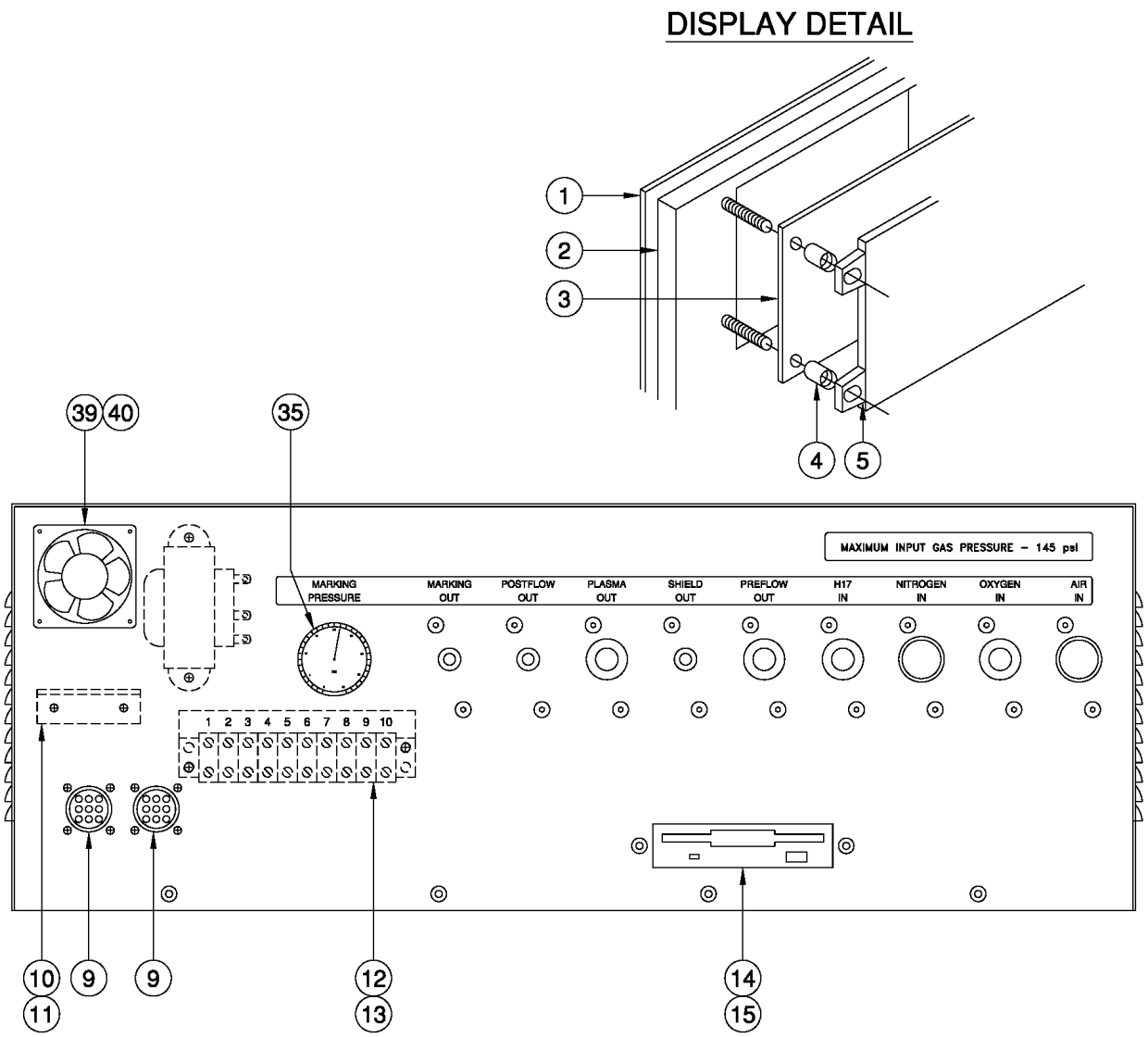
Automatic Gas Console – 1 of 2





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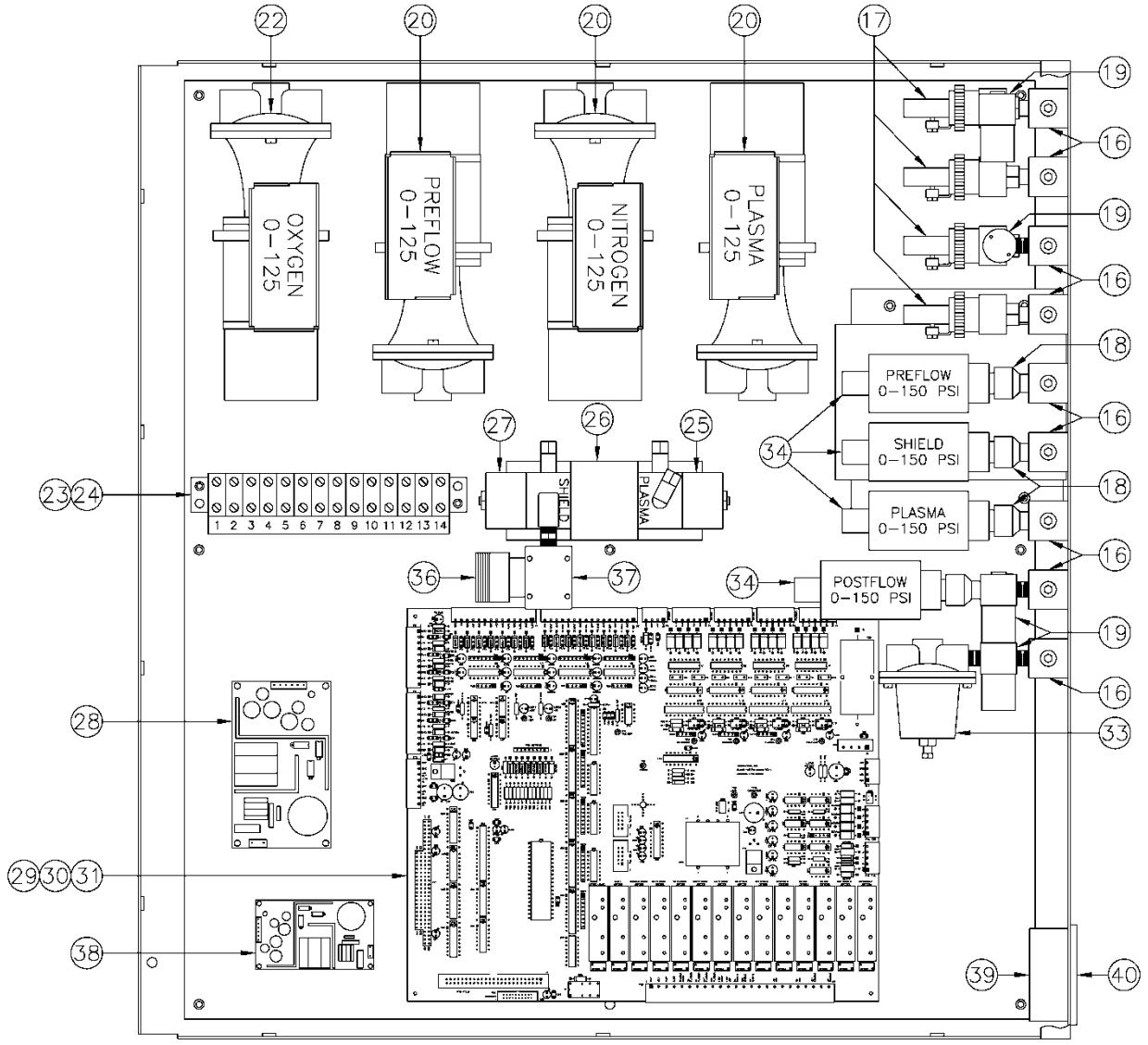
Automatic Gas Console – 2 of 2



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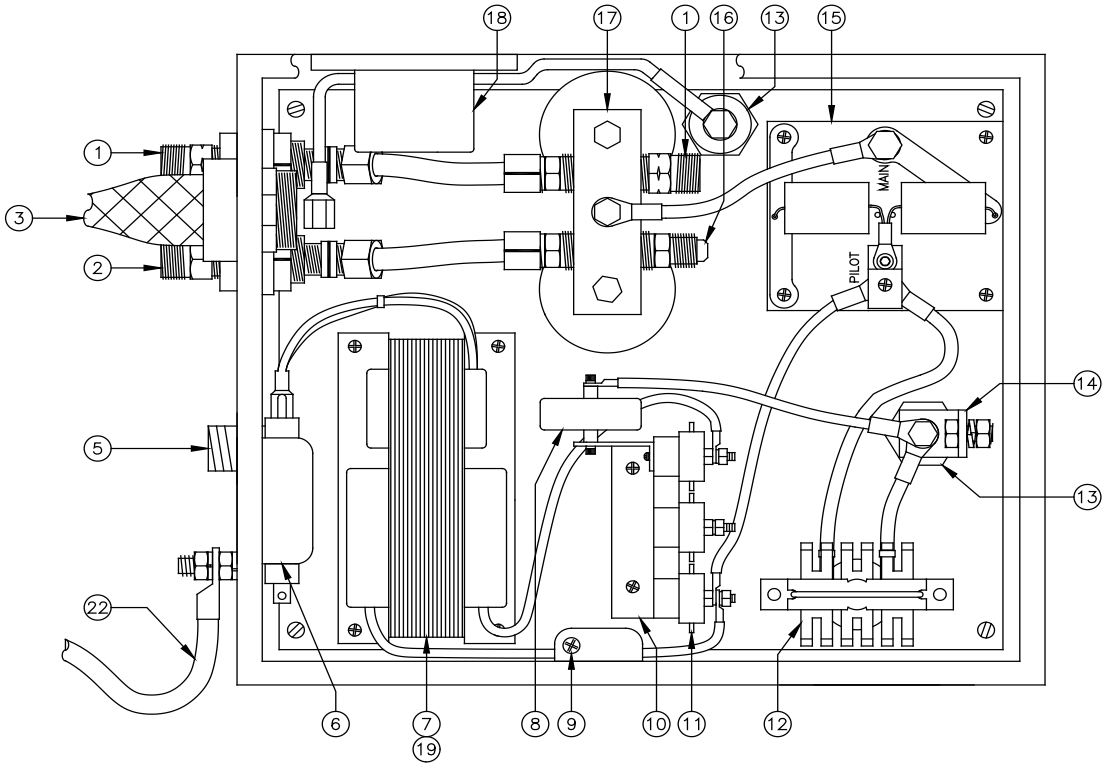
Remote High Frequency Console (Assembly 205500)

Item Number	Part Number	Quantity	Description
1	715051	2	Coolant return fitting (left hand)
2	715050	1	Coolant supply fitting (right hand)
3	709227	1	Strain relief
5	709001	1	4 pin receptacle
6	707001	1	Line filter
7	706109	1	Transformer – 5000V, 20 mA
8	702069	1	Capacitor – 15 kV
9	708057	1	Door interlock switch
10	500014	1	Spark gap assembly
11	740039	3	Spark gap electrode
12	505043	1	High frequency inductor
13	740072	1	Standoff
14	800041	1	Busbar
15	500505	1	RHF console p.c. board assembly
16	715021	1	Coolant supply fitting (right hand)
17	500503	1	Cathode manifold
18	205010	1	CTP sensor lead filter assembly
19	200287	1	Transformer insulating plate
22	500098	1	Ground cable



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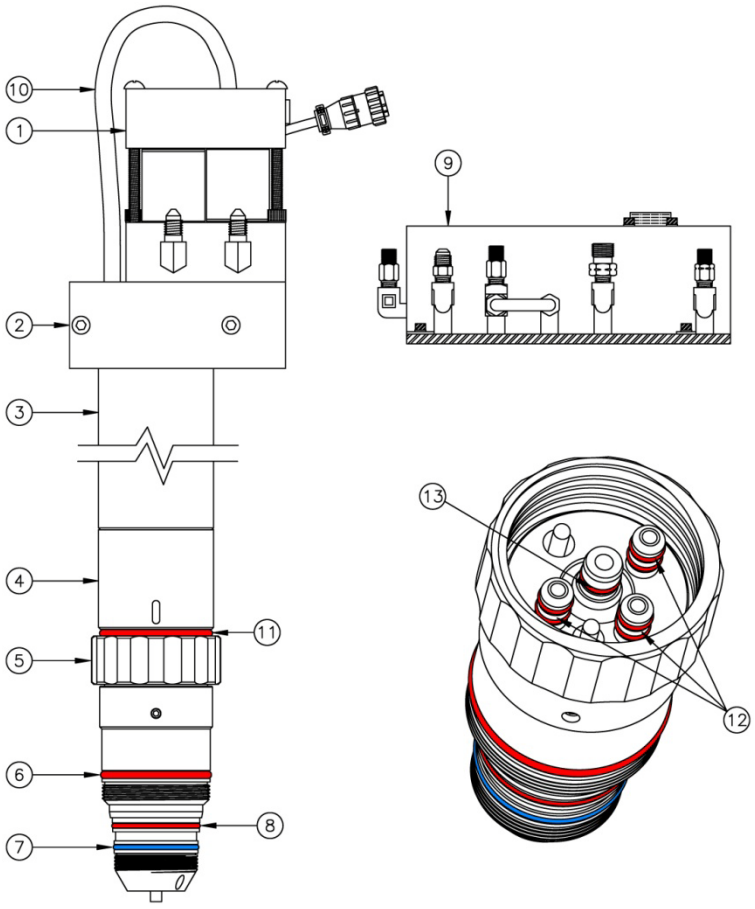
Torch and Manifold Assemblies

Item Number	Part Number	Quantity	Description
1	260214	1	2-gang manifold assembly (includes bracket)
2	277195	1	2-gang manifold bracket
3	820134	1	Torch handle
4	279050	1	Torch Base
5	279150	1	Torch Head (Copper Electrode)
	279160		Torch Head (Silver Electrode)
6	820209	1	O-ring (red)
7	500024	1	O-ring (blue)
8	500018	1	O-ring (red)
9	280022	1	5-gang manifold assembly
10	500740	1	Torch solenoid plasma hose
11	279013	1	O-ring (red) - indicator only, not a seal
12	279113	6	O-ring (red)
13	279112	1	O-ring (red)
Not shown	716012	1	O-ring lubricant
Not shown	277056	1	Nozzle removal tool
Not shown	277086	1	Electrode removal tool driver
Not shown	277087	1	Copper Electrode removal tool
Not shown	279061	1	Silver Electrode removal tool



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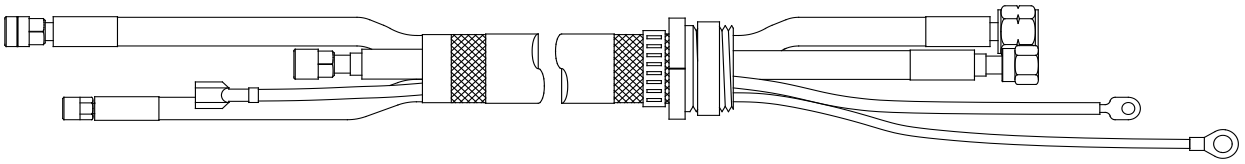
Shielded Torch Leads

Part Number	Length
280304-10	10 ft. (3.0 m)
280304-15	15 ft. (4.6 m)
280304-20	20 ft. (6.1 m)
280304-25	25 ft. (7.6 m)
280304-30	30 ft. (9.1 m)
280304-35	35 ft. (10.7 m)
280304-40	40 ft. (12.2 m)
280304-45	45 ft. (13.7 m)
280304-50	50 ft. (15.2 m)



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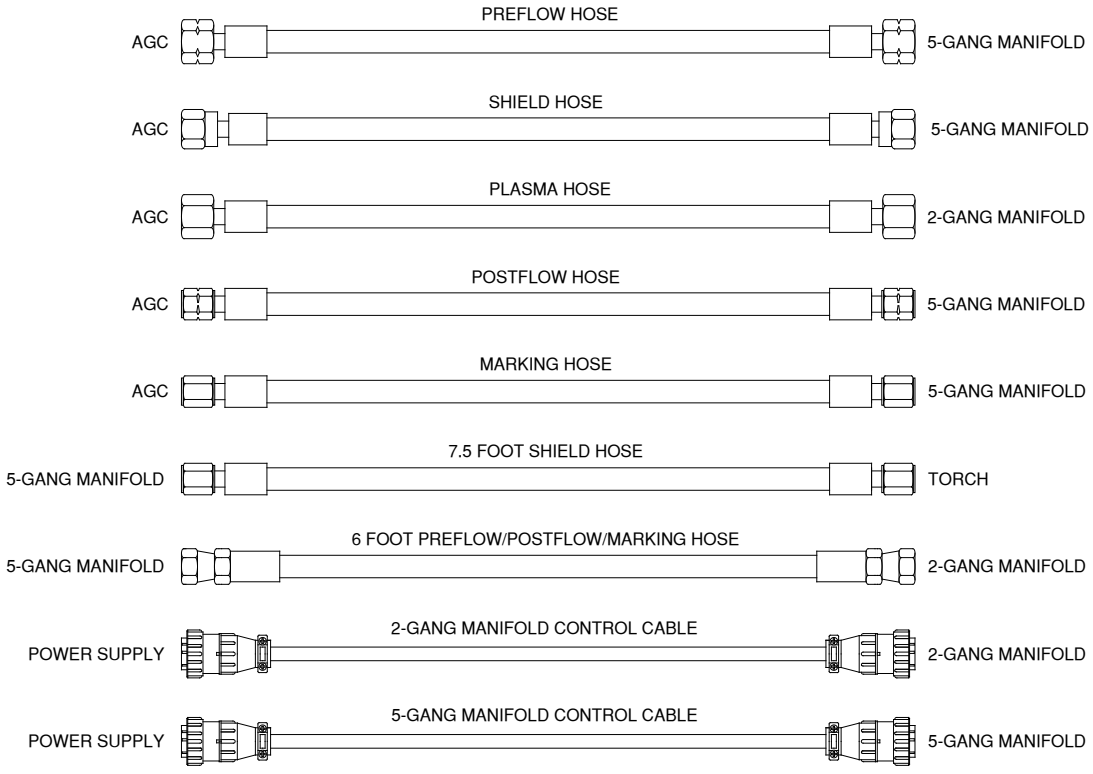
Gas Hose Package

Part Number	Length
280317-20	20 ft. (6.1 m)
280317-25	25 ft. (7.6 m)
280317-30	30 ft. (9.1 m)
280317-35	35 ft. (10.7 m)
280317-40	40 ft. (12.2 m)
280317-45	45 ft. (13.7 m)
280317-50	50 ft. (15.2 m)
280317-55	55 ft. (16.8 m)
280317-60	60 ft. (18.3 m)
280317-65	65 ft. (19.8 m)
280317-70	70 ft. (21.3 m)
280317-75	75 ft. (22.9 m)
280317-80	80 ft. (24.4 m)
280317-85	85 ft. (25.9 m)
280317-90	90 ft. (27.4 m)
280317-95	95 ft. (29.0 m)
280317-100	100 ft. (30.5 m)



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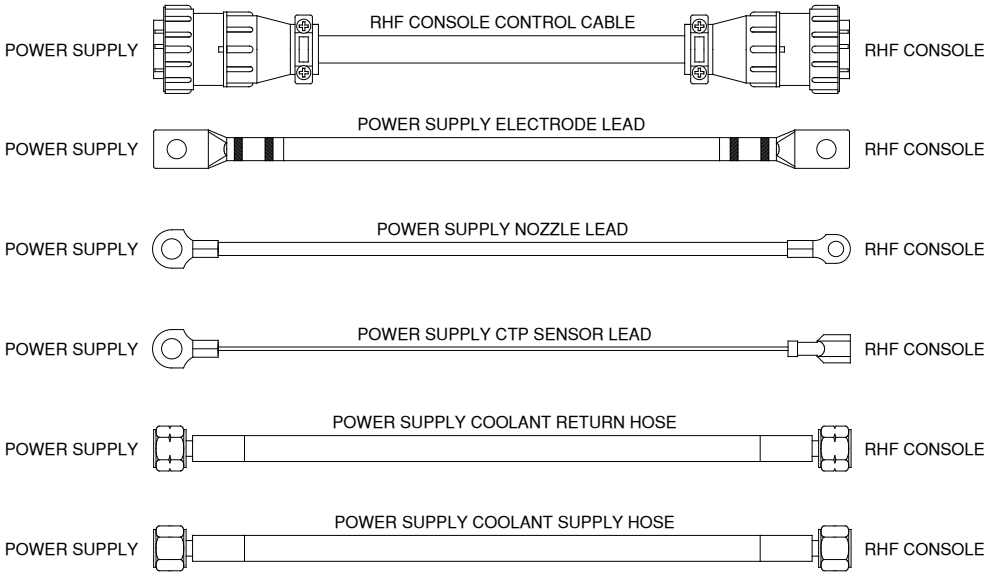
Coolant and Power Leads

Part Number (Non-CSA Systems)	Part Number (CSA Systems)	Length
280306-5	288306-5	5 ft. (1.5 m)
280306-10	288306-10	10 ft. (3.0 m)
280306-15	288306-15	15 ft. (4.6 m)
280306-20	288306-20	20 ft. (6.1 m)
280306-25	288306-25	25 ft. (7.6 m)
280306-30	288306-30	30 ft. (9.1 m)
280306-35	288306-35	35 ft. (10.7 m)
280306-40	288306-40	40 ft. (12.2 m)
280306-45	288806-45	45 ft. (13.7 m)
280306-50	288306-50	50 ft. (15.2 m)
280306-55	288306-55	55 ft. (16.8 m)
280306-60	288306-60	60 ft. (18.3 m)
280306-65	288306-65	65 ft. (19.8 m)
280306-70	288306-70	70 ft. (21.3 m)
280306-75	288306-75	75 ft. (22.9 m)
280306-80	288306-80	80 ft. (24.4 m)
280306-85	288306-85	85 ft. (25.9 m)
280306-90	288306-90	90 ft. (27.4 m)
280306-95	288306-95	95 ft. (29.0 m)
280306-100	288306-100	100 ft. (30.5 m)



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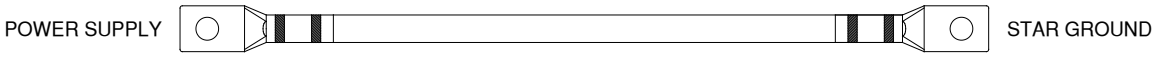
Work Ground Cable

Part Number (Non-CSA Systems)	Part Number (CSA Systems)	Length
280318-10	288318-10	10 ft. (3.0 m)
280318-15	288318-15	15 ft. (4.6 m)
280318-20	288318-20	20 ft. (6.1 m)
280318-25	288318-25	25 ft. (7.6 m)
280318-30	288318-30	30 ft. (9.1 m)
280318-35	288318-35	35 ft. (10.7 m)
280318-40	288318-40	40 ft. (12.2 m)
280318-45	288318-45	45 ft. (13.7 m)
280318-50	288318-50	50 ft. (15.2 m)
280318-55	288318-55	55 ft. (16.8 m)
280318-60	288318-60	60 ft. (18.3 m)
280318-65	288318-65	65 ft. (19.8 m)
280318-70	288318-70	70 ft. (21.3 m)
280318-75	288318-75	75 ft. (22.9 m)
280318-80	288318-80	80 ft. (24.4 m)
280318-85	288318-85	85 ft. (25.9 m)
280318-90	288318-90	90 ft. (27.4 m)
280318-95	288318-95	95 ft. (29.0 m)
280318-100	288318-100	100 ft. (30.5 m)



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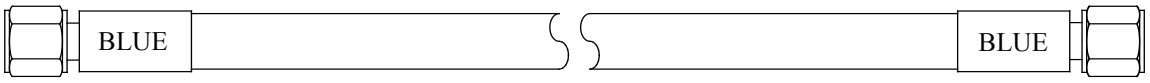
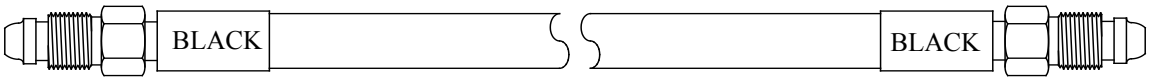
Oxygen Supply Gas Hose (Optional)

Part Number	Length
200362-25	25 ft. (7.6 m)
200362-50	50 ft. (15.2 m)



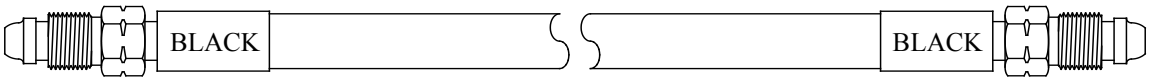
Nitrogen Supply Gas Hose (Optional)

Part Number	Length
200365-25	25 ft. (7.6 m)
200365-50	50 ft. (15.2 m)



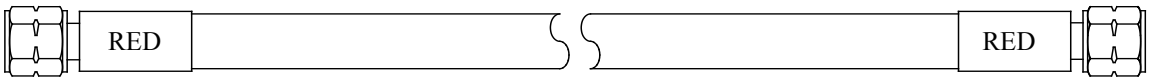
Air Supply Gas Hose (Optional)

Part Number	Length
200364-25	25 ft. (7.6 m)
200364-50	50 ft. (15.2 m)



H17 Supply Gas Hose (Optional)

Part Number	Length
200363-25	25 ft. (7.6 m)
200363-50	50 ft. (15.2 m)



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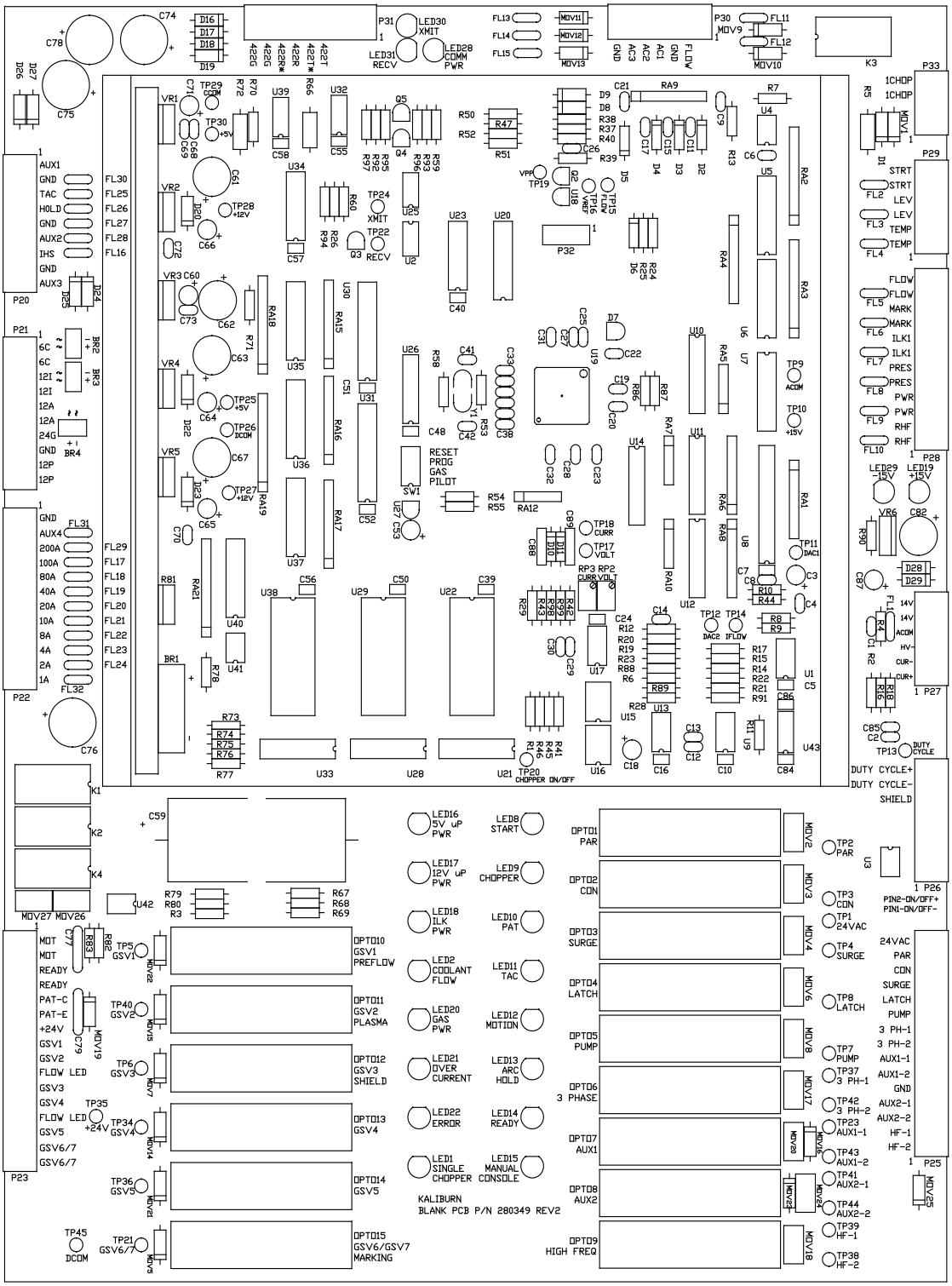
Power Supply Microprocessor P.C. Board (Assembly 280275)



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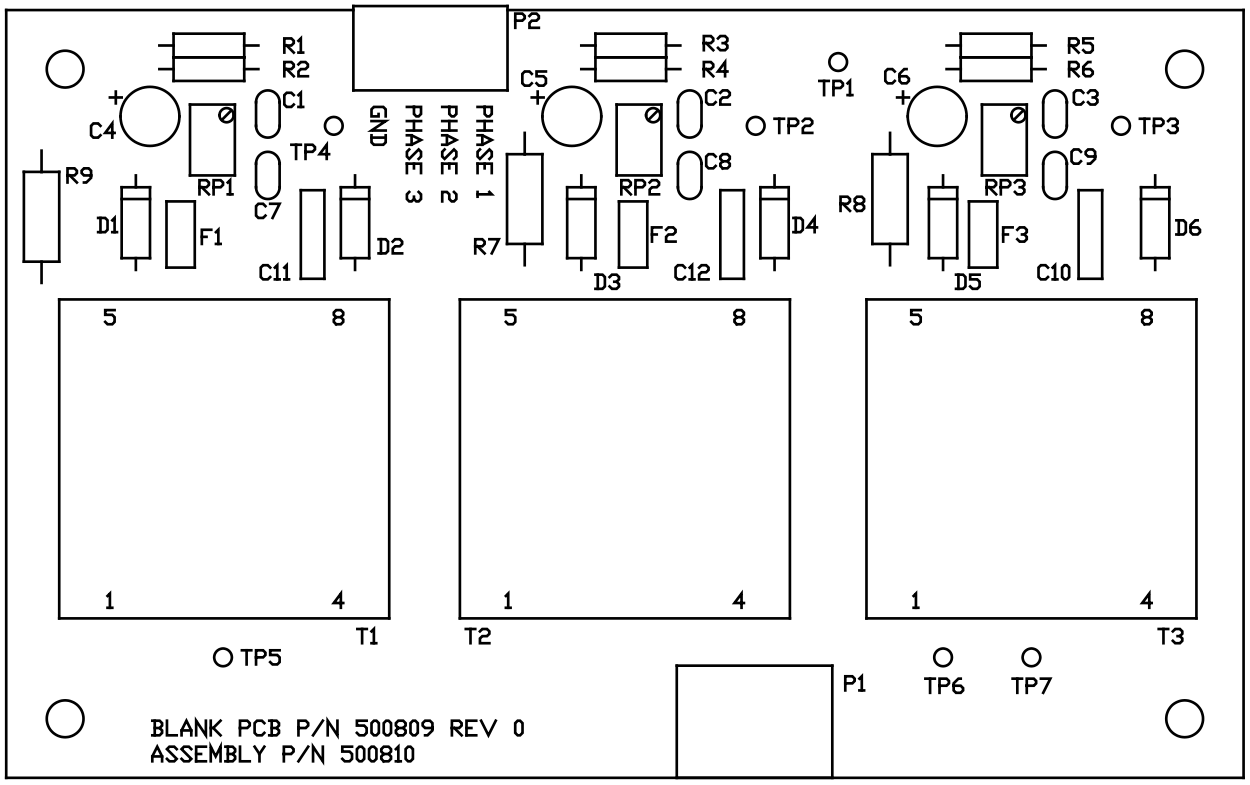
A.C. Detect P.C. Board (Assembly 500810)



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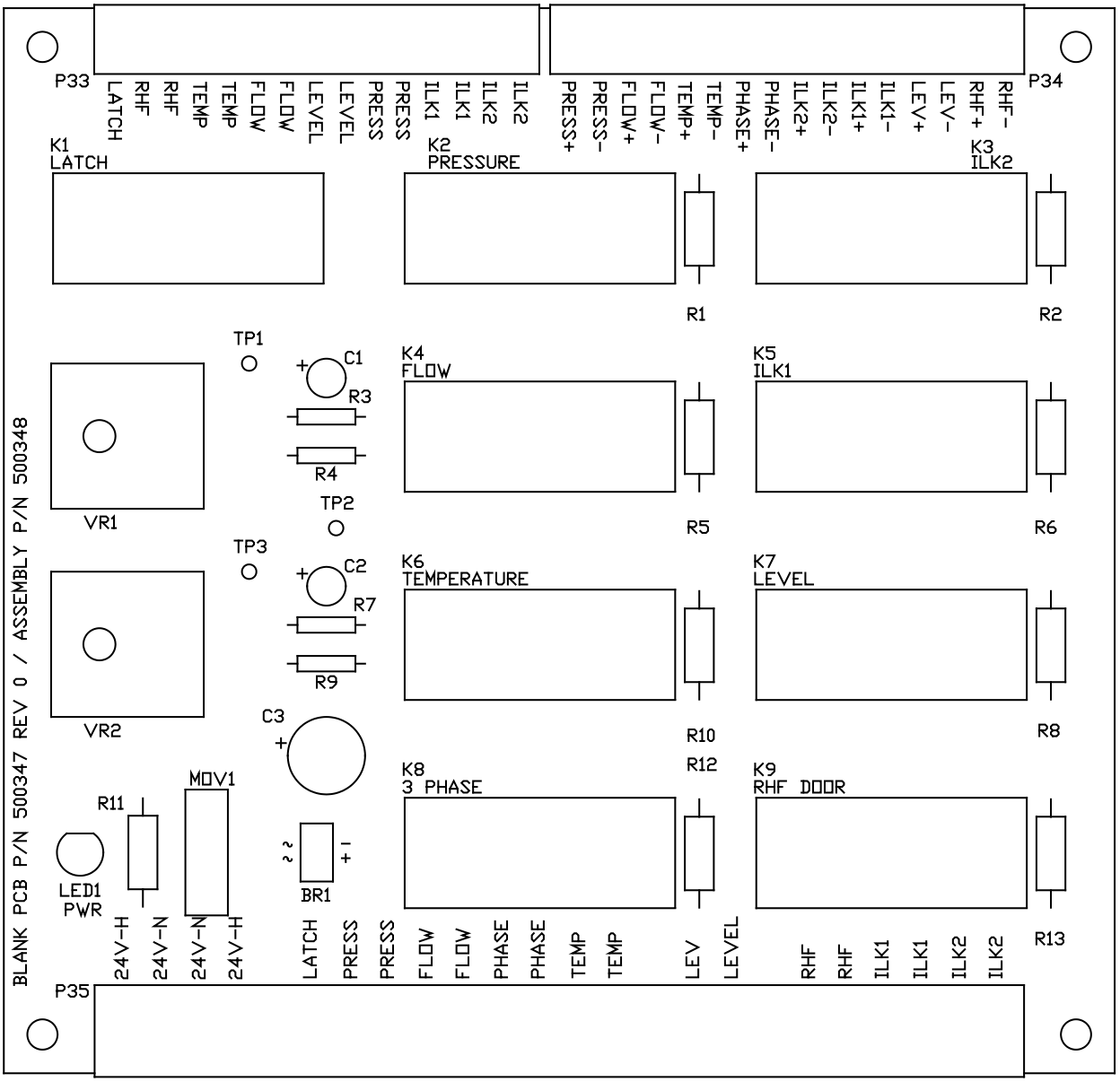
Relay P.C. Board (Assembly 500348)



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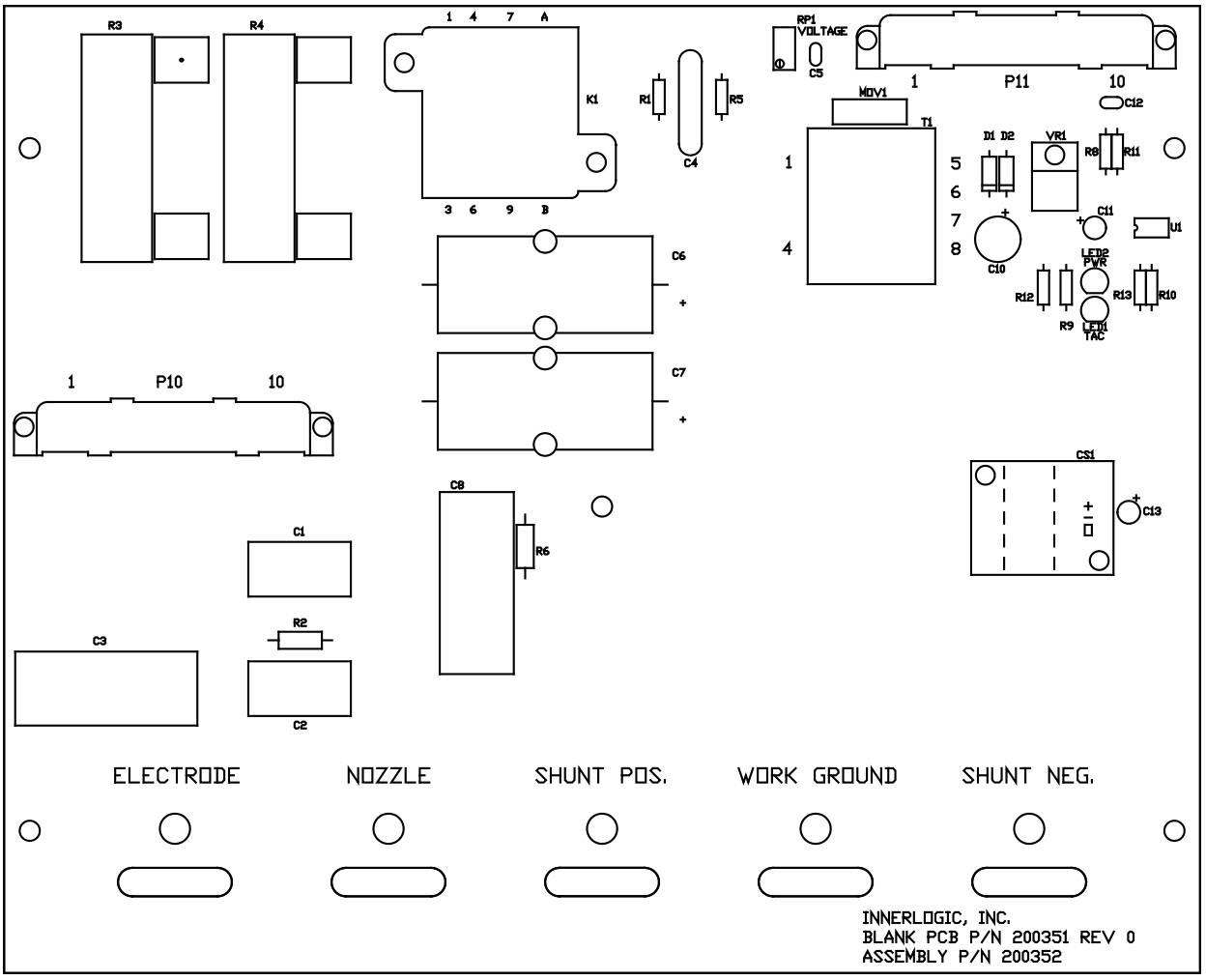
Power Supply I/O P.C. Board (Assembly 277452)



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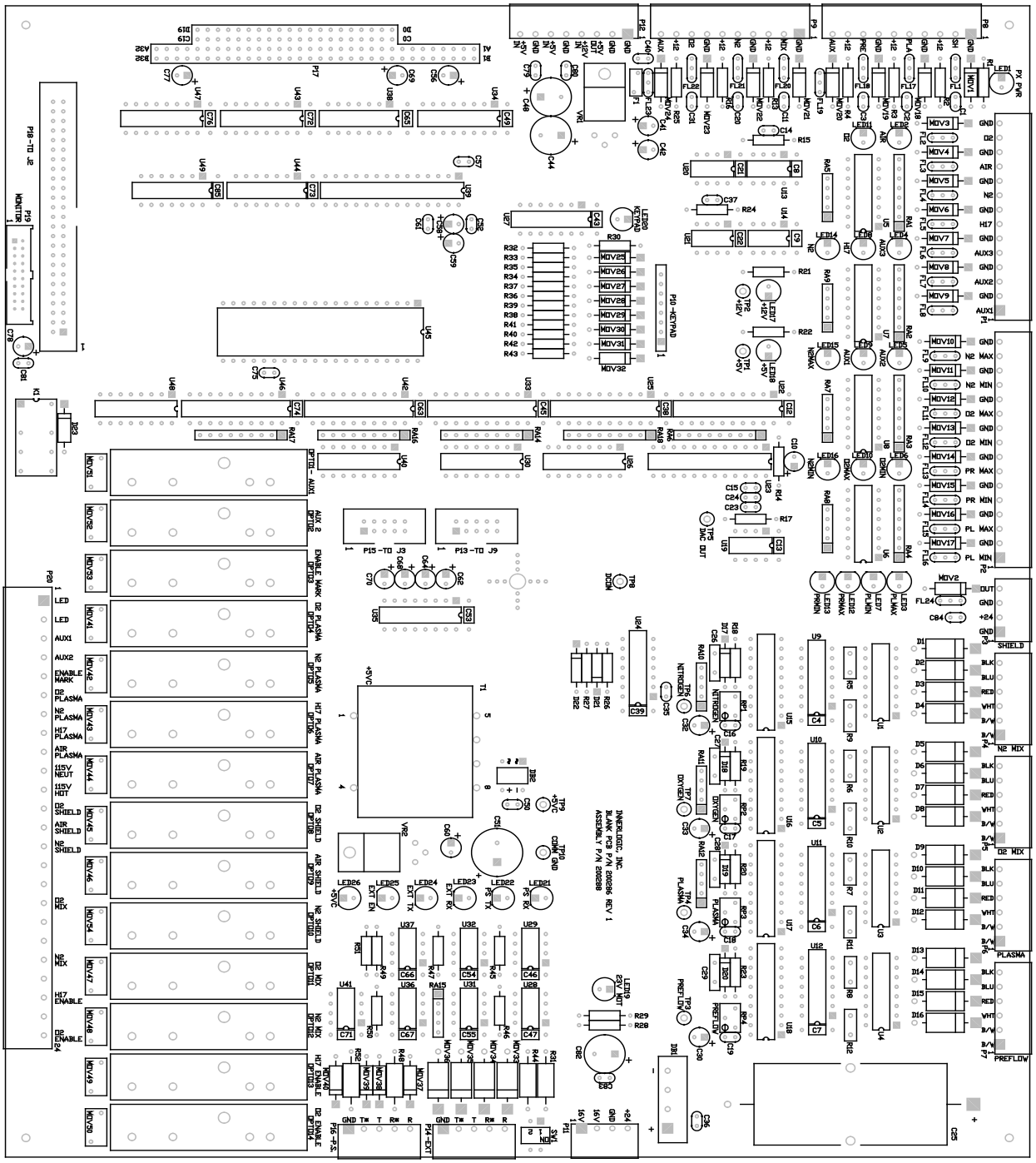
Automatic Gas Console I/O P.C. Board (Assembly 200288)



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Consumable Spare Parts Kit (Part Number 280267)

Part Number	Quantity	Description
277130	3	Electrode 30A Mild Steel - 30A Aluminum
277137	2	Electrode 30/50A Stainless (Air)
277131	6	Electrode 50/70A Mild Steel - 70A Stainless (Air) - 50/70A Aluminum
277132	2	Electrode 70A Stainless (H17)
277282	3	Electrode 100A Mild Steel - 100A Stainless (Air) - 100A Aluminum
277133	2	Electrode 100A Stainless (H17)
277292	3	Electrode 150A Mild Steel – 150A Stainless (Air) – 150A Aluminum
277291	3	Electrode 200A Mild Steel - 200A Stainless (Air) - 200A Aluminum
277135	2	Electrode 150/200/260A Stainless (H17)
277270	3	Electrode 275A Mild Steel – 275A Stainless (Air) – 275A Aluminum
277120	5	Nozzle 30A Mild Steel - 30A Aluminum
277121	3	Nozzle 30A Stainless (Air)
277122	5	Nozzle 50A Mild Steel - 50A Aluminum
277123	3	Nozzle 50A Stainless (Air)
277125	5	Nozzle 70A Mild Steel - 70A Stainless (Air) - 70A Aluminum
277124	3	Nozzle 70A Stainless (H17)
277284	5	Nozzle 100A Mild Steel – 100A Stainless (Air) - 100A Aluminum
277126	3	Nozzle 100A Stainless (H17)
277293	5	Nozzle 150A Mild Steel – 150A Stainless (Air) – 150A Aluminum
277289	5	Nozzle 200A Mild Steel – 200A Stainless (Air) - 200A Aluminum

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Part Number	Quantity	Description
277287	3	Nozzle 200A Stainless (H17)
277118	3	Nozzle 260A Stainless (H17)
277269	5	Nozzle 275A Mild Steel
277276	3	Nozzle 275A Stainless (Air) – 275A Aluminum
277145	3	Shield Cap 30A Mild Steel - 30A Aluminum
277144	3	Shield Cap 30A Stainless (Air)
277149	3	Shield Cap 50A Stainless (Air)
277115	3	Shield Cap 50A Mild Steel
277150	3	Shield Cap 70A Mild Steel - 70A Stainless - 50/70A Aluminum
277286	3	Shield Cap 100A Mild Steel - 100A Stainless (Air) - 100A Aluminum
277146	3	Shield Cap 100A Stainless (H17)
277117	3	Shield Cap 150A Mild Steel – 150A Stainless (Air) – 150A Aluminum
277298	3	Shield Cap 150A Stainless (H17)
277274	3	Shield Cap 200A Mild Steel - 200A Stainless – 200A Aluminum
277211	3	Shield Cap 260A Stainless (H17)
277263	3	Shield Cap 275A Mild Steel – 275A Stainless (Air) – 275A Aluminum
277138	1	Swirl Ring 30A Stainless (Air)
277140	1	Swirl Ring 30/50A Mild Steel - 70A Stainless (H17) - 30A Aluminum
277142	1	Swirl Ring 50/70A Mild Steel - 50/70A Stainless (Air) - 50/70A Aluminum
277283	1	Swirl Ring 100A Mild Steel – 100A Stainless (Air) – 100A Aluminum
277141	1	Swirl Ring 100A Stainless (H17)

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Part Number	Quantity	Description
277139	1	Swirl Ring 150A Mild Steel – 150A Stainless – 150A Aluminum 260A Stainless (H17)
277143	1	Swirl Ring 200A Mild Steel – 200A Stainless (Air) - 200A Aluminum
277259	1	Swirl Ring 200A Stainless (H17)
277258	1	Swirl Ring 275A Mild Steel – 275A Stainless (Air) – 275A Aluminum
277110	1	Inner Retaining Cap 30/50A Stainless (Air)
277153	1	Inner Retaining Cap 30/50/70A Mild Steel - 70A Stainless (Air) 30/50/70A Aluminum
277151	1	Inner Retaining Cap 100A Mild Steel - 100A Stainless (Air) - 100A Aluminum 150A Mild Steel – 1/2" and below
277152	1	Inner Retaining Cap 150A Mild Steel – 5/8" and above – 150A Stainless (Air) 150A Aluminum
277113	1	Inner Retaining Cap 70/100A Stainless (H17)
277266	1	Inner Retaining Cap 150A Stainless (H17) 200/275A Mild Steel – 200A Stainless – 200/275A Aluminum 275A Stainless (Air)
277280	1	Inner Retaining Cap 260A Stainless (H17)
716012	1	O-ring Lubricant
500024	2	Torch O-ring – blue, lower
500018	2	Torch O-ring – red, middle
820209	2	Torch O-ring –black/red, upper
277056	1	Nozzle Removal Tool
277086	1	Electrode Removal Tool Driver
277087	1	Electrode Removal Tool Socket
260105	1	Swirl Ring Removal Tool
277154	1	Outer Retaining Cap

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Appendix A Electromagnetic Compatibility (EMC)

Background

The 380V 50/60Hz and 415V 50/60Hz CE marked Spirit275a plasma cutting systems are manufactured to comply with the European standard EN 60974-10 (Electromagnetic compatibility (EMC) – Product standard for arc welding equipment). The system has been tested in accordance with CISPR 11, EMC classification – Group 2 ISM (Class A).

The limits used in this standard are based on practical experience. However, the ability of plasma cutting equipment to work in a compatible manner with other radio and electronic systems is greatly influenced by the manner in which it is installed and used. For this reason, it is important that the plasma cutting equipment be installed and used in accordance with the information below if electromagnetic compatibility is to be achieved.

Plasma cutting equipment is primarily intended for use in an industrial environment. There may be potential difficulties in ensuring electromagnetic compatibility in other environments.

Installation and Use

The user is responsible for installing and using the plasma cutting equipment according to the manufacturer's instructions. If electromagnetic disturbances are detected then it shall be the responsibility of the user of the plasma cutting equipment to resolve the situation with the technical assistance of the manufacturer. In some cases this remedial action may be as simple as earthing the plasma cutting circuit, see Note. In other cases it could involve constructing an electromagnetic screen enclosing the plasma power source and the work, complete with associated input filters. In all cases, electromagnetic disturbances shall be reduced to the point where they are no longer troublesome.

Note: The plasma cutting circuit may or may not be earthed for safety reasons. Changing the earthing arrangements should only be authorized by a person who is competent to assess whether the changes will increase the risk of injury, e.g. by allowing parallel plasma cutting current return paths which may damage the earth circuits of other equipment. Further guidance is given in IEC 974-13 *Arc welding equipment – Installation and use.*

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Assessment of Area

Before installing plasma cutting equipment, the user shall make an assessment of potential electromagnetic problems in the surrounding area. The following shall be taken into account:

a) other supply cables, control cables, signaling and telephone cables; above, below and adjacent to the plasma cutting equipment;
b) radio and television transmitters and receivers;
c) computer and other control equipment;
d) safety critical equipment, e.g. guarding of industrial equipment;
e) the health of the people around, e.g. the use of pacemakers and hearing aids;
f) equipment used for calibration or measurement;
g) the immunity of other equipment in the environment; the user shall ensure that other equipment being used in the environment is compatible; this may require additional protection measures;
h) the time of day that plasma cutting or other activities are to be carried out.

The size of the surrounding area to be considered will depend on the structure of the building and other activities that are taking place. The surrounding area may extend beyond the boundaries of the premises.

Methods of Reducing Emissions

Mains Supply

Plasma cutting equipment should be connected to the mains supply according to the manufacturer's recommendations. If interference occurs, it may be necessary to take additional precautions such as filtering of the mains supply. Consideration should be given to shielding the supply cable of permanently installed plasma cutting equipment in metallic conduit or equivalent. Shielding should be electrically continuous throughout its length. The shielding should be connected to the plasma power source so that good electrical contact is maintained between the conduit and the plasma power source enclosure.

Maintenance of the Plasma Cutting Equipment

The plasma cutting equipment should be routinely maintained according to the manufacturer's recommendations. All access and service doors and covers should be closed and properly fastened when the plasma cutting equipment is in operation. The plasma cutting equipment should not be modified in any way except for those changes and adjustments covered in the manufacturer's instructions. In particular, the spark gaps of arc striking and stabilizing devices should be adjusted and maintained according to the manufacturer's recommendations.

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Plasma Cutting Cables
The plasma cutting cables should be kept as short as possible and should be positioned close together, running at or close to the floor level.

Equipotential Bonding
Bonding of all metallic components in the plasma cutting installation and adjacent to it should be considered. However, metallic components bonded to the workpiece will increase the risk that the operator could receive a shock by touching these metallic components and the electrode at the same time. The operator should be insulated from all such bonded metallic components.

Earthing of the Workpiece
Where the workpiece is not bonded to earth for electrical safety, nor connected to earth because of its size and position, e.g. ship's hull or building steelwork, a connection bonding the workpiece to earth may reduce emissions in some, but not all instances. Care should be taken to prevent the earthing of the workpiece increasing the risk of injury to users, or damage to other electrical equipment. Where necessary, the connection of the workpiece to earth should be made by a direct connection to the workpiece, but in some countries where direct connection is not permitted, the bonding should be achieved by suitable capacitance, selected according to national regulations.

Screening and Shielding
Selective screening and shielding of other cables and equipment in the surrounding area may alleviate problems of interference. Screening of the entire welding installation may be considered for special applications.

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